Welcome

Since 1998, 3M ESPE has had the honor to support the International Association for Dental Research (IADR) and their premier global conference for the communication of scientific and technological advancements in oral care.

Through our Expertise™ brand, we are pleased to share with you this collection of “Scientific Facts” summarizing current abstracts of the latest research on 3M ESPE products recently published by IADR. In addition, there are reference pages at the end of the Impression Materials, Cements, Prevention and Indirect Restorative sections that feature other 3M ESPE product-focused abstracts for your review.

3M ESPE is in the unique position to leverage more than 40 diverse technology platforms and over 6,500 corporate R&D staff to transform research into innovative products and solutions that benefit dental professionals and their patients. The results of this collaboration have enabled us to be named the “Most Innovative Company in the Dental Industry” for the last nine years. The ranking each year is based on issued patents worldwide, 510k applications and new product introductions.

Whether or not you were able to attend the 2014 conferences this year, we hope you continue to engage our research team as we all work to make better dentistry possible.

Sincerely,

Mitsi T. O’Neill
Global Scientific Affairs and Education Director
3M ESPE
Table of Contents

Direct Restorative

Adhesives and Etchants
- Scotchbond™ Universal Adhesive ................................................................. 4, 5, 6, 7, 8, 9, 10, 11, 12, 13

Composites
- Filtek™ Supreme Ultra Universal Restorative .................................................. 14, 21
- Filtek™ Bulk Fill Flowable Restorative ............................................................. 15-16, 17, 18
- Filtek™ Silorane Low Shrink Posterior Restorative .......................................... 19
- Filtek™ Z550 Nano Hybrid Universal Restorative .............................................. 20
- Filtek™ Z250 Universal Restorative ................................................................. 19, 22
- Filtek™ Z350 Flowable Universal Restorative .................................................. 22
- Filtek™ P60 Posterior Restorative ................................................................. 22
- Concise™ Composite ..................................................................................... 23

Finishing and Polishing
- Sof-Lex™ Spiral Finishing and Polishing Wheels ............................................. 24, 25

Anesthesia
- Ubistesin™ 1,400,000 .................................................................................... 26

Indirect Restorative

Impression Materials and Retraction
- Impregum™ Polyether Impression Material ..................................................... 31-32, 33, 39
- Imprint™ VPS Impression Material ................................................................. 34-35, 43
- Express™ 2 VPS Impression Material ............................................................... 36-37
- Imprint™ 4 VPS Impression Material ............................................................... 27-28, 29-30, 34-35, 36-37, 45
- Imprint™ 4 Preliminary VPS Impression Material .......................................... 42, 43-44
- 3M™ ESPE™ Retraction Capsule/3M™ ESPE™ Astringent Paste ....................... 38
- Impregum™ Penta™ and Penta™ Soft, 3M™ ESPE™ Monophase and Soft Monophase Polyether Impression Material ......................... 40-41

Temporization Materials
- Protemp™ 4/Plus Temporization Materials ..................................................... 27-28, 47, 48, 49, 50, 51, 52

Cements
- RelyX™ Ultimate Adhesive Resin Cement ....................................................... 53, 56
- RelyX™ Luting Plus/Ketac™ Cem Plus Automix Resin Modified Glass Ionomer Cement ................................................................. 54, 55
Table of Contents (cont.)

Indirect Restoratives (cont.)

CAD/CAM

Lava™ Ultimate Restorative ................................................................................................................................. 59, 60, 63, 64, 67-68, 69, 70, 71, 72, 73, 74, 75, 76, 77
Lava™ Plus High Translucency Zirconia ................................................................................................................ 61-62, 65-66, 67-68

Mini Dental Implants

3M™ ESPE™ MDI Mini Dental Implants .............................................................................................................................................. 78, 79

References

Impression Material References .............................................................................................................................................. 46
Cement References ................................................................................................................................................................. 57-58
Indirect Restoratives ................................................................................................................................................................. 80-82

Preventive Products

Vanish™ 5% Sodium Fluoride White Varnish with Tri-Calcium Phosphate (TCP) ................................................................. 83, 86
Vanish™ XT Extended Contact Varnish ................................................................................................................................. 85, 89
Clinpro™ 5000 1.1% Sodium Fluoride Anti-Cavity Toothpaste ................................................................................................. 87
New Air-Polishing Powder ....................................................................................................................................................... 84, 88

References

Preventive References ................................................................................................................................................................. 90-92
**Scotchbond™ Universal Adhesive**

Adhesion to Saliva Contaminated Zirconia Cleaned with Different Methods

C. THALACKER1, G. RAIA1, R. HECHT1, S. HADER1 and D. KRUEGER2, 13M Deutschland GmbH, Seefeld, Germany, 23M ESPE, Saint Paul, MN

**Objectives:** Saliva contamination of zirconia restorations before final cementation can lead to lower bond strength. Aim of this study was to assess the effect of the cleaning protocol (water or Ivoclean (ICL, Ivoclar-Vivadent) on shear bond strength (SBS) of RelyX™ Ultimate Adhesive Resin Cement (RXU, 3M ESPE) using Scotchbond™ Universal Adhesive (SBU, 3M ESPE) as zirconia primer to saliva contaminated zirconia (Lava™ Plus High Translucency Zirconia, 3M ESPE).

**Methods:** Sandblasted zirconia discs were contaminated with human saliva and divided into the following groups (n=5): rinsing with water and air drying (water/air), ICL with rinsing according to manufacturer’s instructions (ICL/water/air), ICL without rinsing (ICL/no rinsing), saliva without cleaning (no cleaning), uncontaminated zirconia (control). Stainless steel rods (4mm diameter) were cemented onto the zirconia specimens under standardized pressure (20g/mm²) using RXU and SBU according to manufacturer’s instructions. Specimens were stored for 24 hours at 36°C and 100% relative humidity. Half of the specimens were artificially aged (5.000 thermal cycles (TC), 5–55°C, 30 seconds dwell time). SBS was measured using a universal testing machine (Zwick Z010, crosshead speed: 0.75mm/minute).

**Results:** See table. The standard deviations (SD) are given in parentheses. All data per experiment 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>Group</th>
<th>SBS[MPa]_24 hours</th>
<th>SBS[MPa]_TC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water/Air</td>
<td>51.0 (5.1)</td>
<td>50.7 (8.5)</td>
</tr>
<tr>
<td>ICL/Water/Air</td>
<td>46.9 (4.1)</td>
<td>45.4 (5.9)</td>
</tr>
<tr>
<td>ICL/No Rinsing</td>
<td>53.5 (8.0)</td>
<td>48.6 (12.3)</td>
</tr>
<tr>
<td>No Cleaning</td>
<td>43.1 (7.4)</td>
<td>46.2 (9.6)</td>
</tr>
<tr>
<td>Control</td>
<td>55.1 (6.1)</td>
<td>47.6 (5.2)</td>
</tr>
</tbody>
</table>

**Conclusions:** Multiple statistically significant differences were found for 24 hours SBS. No significant difference was found for artificially aged samples. For RXU and SBU, ICL treatment did not improve SBS versus water rinsing. For RXU, water rinsing followed by air drying and SBU application can be recommended in case of saliva contamination of zirconia restorations.

**3M ESPE Summary**

**Aim of Study:** To determine the easiest protocol for bonding to a zirconia surface that was contaminated with saliva when using Scotchbond™ Universal Adhesive and RelyX™ Ultimate Adhesive Resin Cement.

**Summary of Results:** Simply rinsing the saliva contaminated surface with water and drying was sufficient to allow for high bond strengths rather than incorporating a specialized cleaning product.
Scotchbond™ Universal Adhesive

Two Years Storage Stability of Scotchbond™ Universal Adhesive

D.D. KRUEGER1, C. THALACKER2 and H. LOLL2, 13M ESPE Company, Saint Paul, MN, 23M Deutschland GmbH, Seefeld, Germany

Objectives: Modern adhesives are complex formulations that combine a plurality of different functional monomers in one bottle. Reactions between these monomers or evaporation of components might potentially affect shelf life and/or bond strength. Aim of this study was to assess the shear bond strength (SBS) in self etch (SE) and total etch (TE) application modes of Scotchbond™ Universal Adhesive (SBU, 3M ESPE) stored in its vial at room temperature (RT, 23°C) for 0, 12 and 24 months.

Methods: Bovine incisors were embedded in cold-cure acrylic resin. The labial surface of each tooth was ground to expose enamel (E) or dentin (D). A cylindrical button of Filtek™ Z250 Universal Restorative A3 (3M ESPE, 2.36mm diameter, 2mm height) was cured on the tooth surfaces treated with SBU in SE and TE modes according to the manufacturer’s instructions, (n=5). A notched-edge shear method (Ultradent) was used to measure the SBS.

Results: The table shows the SBS in MPa. The standard deviations (SD) are given in parentheses. All data per substrate and application mode 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></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0 months</td>
<td>27.5 (2.7)A</td>
<td>36.3 (4.1)A</td>
<td>33.5 (2.9)A</td>
<td>32.0 (4.4)A</td>
</tr>
<tr>
<td>12 months</td>
<td>22.7 (4.9)B</td>
<td>27.4 (2.8)B</td>
<td>28.5 (2.5)B</td>
<td>28.3 (3.7)A</td>
</tr>
<tr>
<td>24 months</td>
<td>23.8 (1.8)AB</td>
<td>28.1 (4.5)B</td>
<td>29.5 (3.2)AB</td>
<td>31.8 (5.9)A</td>
</tr>
</tbody>
</table>

Conclusions: Several statistically significant differences were found. On all substrates with all application modes, high SBS of well over 20 MPa were obtained for fresh SBU and product stored for 24 months at RT.

3M ESPE Summary

Aim of Study: To evaluate the stability of Scotchbond™ Universal Adhesive and the ability to provide consistent adhesion over the course of the 24 month room temperature shelf life.

Summary of Results: Sufficient adhesion values were obtained for the Scotchbond™ Universal Adhesive over the 24 month shelf life period showing good product stability.
Scotchbond™ Universal Adhesive

Effect of a Hydroxyapatite Forming Desensitizer on Dentin Bond Strength

R. BANSAL, S.S. SONAVANE, R. RADHAKRISHNAN, L.C. RAMP, P. BECK and J. BURGESS, School of Dentistry, University of Alabama at Birmingham, Birmingham, AL

Objectives: To measure the dentin shear bond strength (SBS) of four adhesives before and after an application of a hydroxyapatite (Tetracalcium phosphate and dicalcium phosphate anhydrate, Teethmate Desensitizer, Kuraray) forming desensitizer.

Methods: Freshly extracted intact human molars (n=80) were wet-ground with a series of abrasive discs (80–320-grit) to obtain flat dentin surfaces. Teeth were randomly divided into eight groups of ten specimens each. Half were treated with TEETHMATE Desensitizer (Kuraray Noritake Dental, Tokyo, Japan) according to the manufacturer’s instructions. No desensitizer was applied to the remaining teeth (control). Clearfil Universal Bond was used in the self-etch technique and all other adhesives were used in the total-etch technique. Adhesives were applied to the bonding area according to manufacturer’s instructions and light cured. A tube (diameter=1.5mm) filled with Clearfil AP-X composite resin (Kuraray Noritake Dental, Japan) was placed over the adhesive and light cured (S10 LED curing light 3M ESPE, Saint Paul, MN/820Mw/cm²/20 seconds) from four directions. Specimens were stored (incubator/24 hours/ 37ºC/distilled water). Specimens were placed into a stainless steel fixture mounted on a universal testing machine (Instron- 5565, MA) and loaded to failure (1mm/minute) and statistically analyzed (ANOVA and Tukey T post-hoc test (p=0.05).

Results: (n=10/group) (Mean ± SD).

<table>
<thead>
<tr>
<th>Adhesive/Manufacturer</th>
<th>Adhesive and Etch Mode</th>
<th>Adhesion Promoter</th>
<th>Before Desensitizer Application</th>
<th>After Desensitizer Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scotchbond Universal/3M ESPE</td>
<td>Total-etch, one bottle</td>
<td>MDP</td>
<td>25.4 ± 12</td>
<td>25.4 ± 3</td>
</tr>
<tr>
<td>Optibond Solo Plus/Kerr</td>
<td>Total-etch- one bottle</td>
<td>GPDPM</td>
<td>27.3 ± 8</td>
<td>30.1 ± 9</td>
</tr>
<tr>
<td>Prime and Bond NT/Dentsply</td>
<td>Total-etch-one bottle</td>
<td>PENTA</td>
<td>24.3 ± 7</td>
<td>25.6 ± 11</td>
</tr>
<tr>
<td>Clearfil Universal Bond/Kuraray</td>
<td>Self-etch, one bottle</td>
<td>MDP</td>
<td>25.6 ± 10</td>
<td>30.8 ± 13</td>
</tr>
</tbody>
</table>

Conclusions: The application of Teethmate desensitizer to dentin did not affect bond strengths of four adhesives (p>0.05).

3M ESPE Summary

Aim of Study: To determine the impact on adhesion when a desensitizing agent (Teethmate) was first applied to the dentin prior to application of various adhesives, including Scotchbond™ Universal Adhesive.

Summary of Results: The use of the Teethmate Desensitizing agent did not have an impact on the adhesion values obtained with Scotchbond™ Universal Adhesive.
Enamel Etching Patterns of Universal Adhesives — FESEM Analyses

J. PERDIGAO1, M.A. MUÑOZ2, I.V. LUQUE-MARTINEZ3, A. REIS4 and A.D. LOGUERCIO4, 1University of Minnesota, Minneapolis, MN, 2Universidade Estadual de Ponta Grossa, Ponta Grossa-PR, Brazil, 3Universidade Estadual de Ponta Grossa, Ponta Grossa-Parana, Brazil, 4Universidade Estadual de Ponta Grossa, Ponta Grossa, PR, Brazil

Objectives: To assess the etching effects of universal adhesives applied actively or inactively on human enamel, using two methods of FESEM specimen preparation (direct and resin replica).

Methods: Enamel rectangles of extracted molars were divided into 12 groups (n=4), according to the adhesive, strategy and application mode: Scotchbond™ Universal Adhesive (3M ESPE) [Sc], self-etch/inactive [ScSeI], self-etch/active [ScSeA] and etch-and-rinse [ScEr]; All-Bond Universal (Bisco) [Al], self-etch/inactive [AlSeI], self-etch/active [AlSeA] and etch-and-rinse [AlEr]; Prime & Bond Elect (Dentsply) [Pb], self-etch/inactive [PbSeI], self-etch/active [PbSeA] and etch-and-rinse [PbEr]; Gaenial Bond (GC) [Ga], self-etch/inactive [GaSeI], self-etch/active [GaSeA] and etch-and-rinse [GaEr]. Each adhesive (ER, SEI and SEA) was applied in enamel rectangles from the same tooth and processed using two methods of specimen preparation for FESEM. (a) Direct technique — The enamel specimens were immersed in acetone in a rotator immediately after the application of the adhesive. Specimens were left in acetone for two hours followed by 12 hours; (b) Replica technique — The adhesive was light-cured as per manufacturer's instructions, followed by a 2mm-thick layer of Opallis Flow flowable composite (Seadent). The specimens were immersed in 6NHCl for 12 hours in a rotator to obtain a resin replica of the surface. Specimens were mounted on Al stubs, vacuum-dried and sputter-coated with gold/palladium. FESEM micrographs were obtained from each specimen at standard magnifications and evaluated by a blind evaluator.

Results: The etch-and-rinse strategy resulted in the deepest etching pattern. The inactive application of the self-etch strategy resulted in a poor etching pattern, which was slightly improved with active application. The resin replicas of Pb and Ga displayed droplets.

Conclusions: A deep enamel pattern etching was only achieved when the etch-and-rinse strategy was used, despite the slight increase in enamel roughness when adhesives were applied in the self-etch mode with active versus inactive application. The FESEM observations of HEMA-free universal adhesives (Pb, Ga) suggest phase-separation reactions.

3M ESPE Summary

Aim of Study: To determine the effectiveness for universal adhesives to bond to enamel with and without etching.

Summary of Results: Due to the higher pH of the universal adhesives, pre-etching the enamel with phosphoric acid allows for higher bond strengths. This provides further support for utilizing the selective enamel-etch protocol when utilizing the self-etch procedure for dentin with Scotchbond™ Universal Adhesive as well as the other universal adhesives.
Scotchbond™ Universal Adhesive

Modes of Use of a Universal Adhesive-System to Eroded Dentin

C.M. MACHADO1, M.C. GIACOMINI1, O. BIM JÚNIOR1, A.C. MAGALHÃES2, P.A. ARAÚJO1, M.T. ATTA1 and L. WANG1, 1Bauru School of Dentistry, University of São Paulo, Bauru, Brazil, 2Bauru School of Dentistry — University of São Paulo, Bauru, Brazil

Objectives: Two major categories of dentin bonding systems (etch-and-rinse and self-etching) are available, which differs regarding the mode of use and the stability of the adhesive/dentin interface. The aim of this in vitro study was to compare two modes of use recommended by the universal adhesive system (Scotchbond™ Universal Adhesive) in artificially eroded dentin.

Methods: Extracted caries-free human third molars had their occlusal thirds sectioned to remove enamel and ground flat dentin, which was submitted to a 600-grit SiC paper/one minute and assigned into four groups (n=10): C-ER (control dentin and etch-and-rinse mode), ERO-ER (eroded dentin and etch-and-rinse), C-SE (control dentin and self-etching) and ERO-SE (eroded dentin and self-etching). For the simulation of dentin erosion, 3x/five minute cycles/day in five days were performed with orange juice. Dentin was treated according to the manufacturer instructions. Composite buildups were constructed incrementally with Filtek™ Z250 Universal Restorative. After storage in artificial saliva (7 days/37°C), the specimens were sectioned in beams, which were tested immediately by microtensile bonding strength (µTBS/MPa). The mode failure of fractured specimens was analyzed using optical microscope (x40). Data was statistically analyzed with two-way ANOVA and Bonferroni tests (p<0.05).

Results: Mean µTBS values (MPa ± SD) were: C-ER 37.86 ± 0.72; C-SE 36.14 ± 1.19; ERO-ER 32.02 ± 5.83; ERO-SE 34.11 ± 4.04. The adhesive and mixed failures were predominant in all groups. Both of the the mode of use allowed similar performance irrespective of the substrate (p=0.87). Eroded dentin decreased the µTBS when treated using the ER mode (p=0.001). There was no significant effect between the interaction of both factors (p=0.10).

Conclusions: SE mode seems to be less susceptible to the influence of the mode of use of this multimode universal adhesive system, regardless of the dentin condition.

3M ESPE Summary

Aim of Study: To evaluate the effectiveness for Scotchbond™ Universal Adhesive compared to bond to intact and eroded dentin used in the etch-and-rinse and self-etch modes of use.

Summary of Results: Scotchbond™ Universal Adhesive provided consistent bonding to both intact and eroded dentin in both modes of use.

Results found in abstracts for Scotchbond™ Universal Adhesive also apply to products registered under the following names:
Single Bond Universal Adhesive and Adhesive EXL 759.
Scotchbond™ Universal Adhesive

Clinical Performance of a Self-Etch Adhesive Evaluated: Year-One Results

R.J. CRISP and F.T. BURKE, University of Birmingham, Birmingham, England

Objectives: To evaluate the clinical performance of pairs of restorations formed in Filtek™ Supreme XTE Universal Restorative*, placed using Scotchbond™ Universal Adhesive* (*3M ESPE, Seefeld, Germany) adhesive in total-etch and self-etch applications in a split-mouth design study over three-years.

Methods: Five general dental practitioners (GDPs) of the PREP Panel, the UK practice-based research group, participated. After ethical approval was obtained each GDP was asked to place 10 paired restorations formed in Filtek™ Supreme XTE Universal Restorative and using Scotchbond™ Universal Adhesive, one placed using the adhesive in total-etch mode and the other in self-etch mode. The restorations were reviewed at one-year, +/- three months, by one independent examiner along with the practitioner who placed the restorations, using modified USPHS criteria.

Results: To date 34 restorations, 17 of each placement mode, (comprised of three Class I & 31 Class II) of mean age 12.5 months in 12 patients (eight Female and four Male) in two of the five centers have been examined with results as tabulated:

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Total-Etch Group</th>
<th>Self-Etch Group</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retention</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Anatomic Form</td>
<td>94% A, 6% B</td>
<td>88% A, 12% B</td>
<td>92% A</td>
</tr>
<tr>
<td>Marginal Integrity</td>
<td>82% A, 18% B</td>
<td>88% A, 12% B</td>
<td>85% A</td>
</tr>
<tr>
<td>Marginal Staining</td>
<td>59% A, 41% B</td>
<td>88% A, 12% B</td>
<td>74% A</td>
</tr>
<tr>
<td>Percentage of Margin Stained</td>
<td>3% (range 2 to 10%)</td>
<td>8% (range 5 to 10%)</td>
<td>6%</td>
</tr>
<tr>
<td>Colour Match</td>
<td>100% A</td>
<td>100% A</td>
<td>100% A</td>
</tr>
<tr>
<td>Surface Roughness</td>
<td>88% A, 12% B</td>
<td>100% A</td>
<td>94% A</td>
</tr>
</tbody>
</table>

No secondary caries was detected and no sensitivity reported.

Conclusions: The results of this study indicate that restorations placed, using Scotchbond™ Universal Adhesive in both modes, in the patients reviewed to date were performing satisfactorily after one year.

3M ESPE Summary

Aim of Study: To evaluate the one year clinical in-vivo performance of Scotchbond™ Universal Adhesive when used in the total-etch or the self-etch mode of use.

Summary of Results: The use of Scotchbond™ Universal Adhesive allowed for satisfactory clinical results after one year.
Objectives: To evaluate the effect of different primers on bond strength between resin cements and zirconia after 24 hours and six months in water.

Methods: One hundred and twenty cylinders (3mm diameter) of zirconia (Zirkonzahn) were fabricated, polished, sandblasted with aluminum oxide and randomly distributed in 5 groups (n=24): Group 1 = Scotchbond™ Universal Adhesive (3M ESPE); Group 2 = Signum Zirconia Bond I + II (Heraeus Kulzer); Group 3 = Z-Prime Plus (Bisco); Group 4 = MZ primer experimental (Angelus). On group 5, resin cement only (control). For all the groups tygon tubes (0.8mm diameter and 1mm height) were positioned to insert the Bis-GMA-based dual-cure resin cement (Duo-Link, Bisco) and light-cured for 40 seconds. Samples were submitted to micro-shear bond strength test using a universal testing machine (0.5mm/minute, Instron 4444), either 24 hours or six months after water storage (37°C). Two-way ANOVA and Tukey post-hoc test (p<0.05) were used to evaluate bond strength results.

Results: Mean bond strength, standard deviation and Tukey results may be observed in the table. Bond strength was influenced by the bonding strategy (p=0.0001). There was no effect of storage time on bond strength (p=0.841). The “cement only” group results in low bond strength.

<table>
<thead>
<tr>
<th>Group</th>
<th>24 Hours</th>
<th>6 Months</th>
</tr>
</thead>
<tbody>
<tr>
<td>G1</td>
<td>14.6 ± 4.7 a</td>
<td>16.0 ± 4.8 a</td>
</tr>
<tr>
<td>G2</td>
<td>14.0 ± 5.4 a</td>
<td>11.9 ± 2.6 a</td>
</tr>
<tr>
<td>G3</td>
<td>8.0 ± 1.8 b</td>
<td>8.6 ± 3.3 b</td>
</tr>
<tr>
<td>G4</td>
<td>1.2 ± 0.5 c</td>
<td>0.6 ± 0.7 c</td>
</tr>
<tr>
<td>G5</td>
<td>1.0 ± 1.2 c</td>
<td>1.3 ± 1.2 c</td>
</tr>
</tbody>
</table>

Table 1: Bond strength (MPa ± SD) and Tukey results for experimental groups after 24 hours and 6 months.

Conclusions: All groups presented stable bond strength to zirconia after six months in water. Bond strength between zirconia and a bis-GMA-based cement is affected by specific bonding strategies.

3M ESPE Summary

Aim of Study: To evaluate the effectiveness of Scotchbond™ Universal Adhesive to bond to sandblasted zirconia compared to using various zirconia priming systems.

Summary of Results: Scotchbond™ Universal Adhesive provided for the highest bond strength and a stable bond strength to the zirconia substrate compared to the other primer systems used.
Scotchbond™ Universal Adhesive

Clinical Evaluation of a Universal Adhesive in Class V Restorations

A. ROBLES1, D.A. GIVAN1, B. WALDO1, L. RAMP1, D. CAKIR2 and J. BURGESS2, 1University of Alabama at Birmingham, Birmingham, AL, 2School of Dentistry, University of Alabama at Birmingham, Birmingham, AL

**Objectives:** To compare the clinical performance of a Universal adhesive in a self and total etch mode to a two bottle total-etch dental adhesive in the restoration of non-carious cervical lesions (NCCLs).

**Methods:** 43 adult subjects, 19 years or older, were recruited after obtaining informed consent. To be included each subject had at least three 1.5mm deep NCCLs. The teeth were restored randomly with Scotchbond™ Universal Adhesive total-etch (SBU-TE), Scotchbond™ Universal Adhesive SBU-SE or Scotchbond™ MP-SBMP dental adhesives. All were restored with Filtek™ Supreme Ultra Universal Restorative (3M ESPE) composite resin. Teeth were isolated (rubber dam) and cleaned (pumice/water). A short enamel bevel was made with an OS2 bur (Brasseler/GA) on the enamel margin and high speed handpiece (NSK/Japan). All adhesives were applied following manufacturers’ directions. Proper composite shade was selected, placed in 2mm increments and light-cured (Elipar™ S10 LED Curing Light 3M ESPE>700mW/cm²). Restorations were finished with burs (7901/OS2/Brasseler) and polished (Sof-Lex™ Finishing and Polishing/3M ESPE, Enhance/PoGo, Dentsply Caulk). Digital images were made before and after preparation, after finishing and at each recall. Patients were evaluated at baseline (two weeks after restoration), six and 12 months. Each evaluation included retention, anatomic form, color match, margin integrity, margin discoloration, surface roughness, secondary caries, staining, gingival index and post-operative cold sensitivity using modified USPHS Criteria. The data were evaluated with McNemar’s test (p=0.05).

**Results:** Of all placed restorations evaluated at 12-month recall, four restorations failed. Marginal discoloration for SBU-TE, SBU-SE and SBMP were 95%, 91% and 97% after 12 months, respectively.

<table>
<thead>
<tr>
<th>Materials</th>
<th>Retention Rate</th>
<th>Baseline/n=42</th>
<th>12 Months/n=42</th>
</tr>
</thead>
<tbody>
<tr>
<td>SBMP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A*</td>
<td>100</td>
<td>97%</td>
<td></td>
</tr>
<tr>
<td>C**</td>
<td>0</td>
<td>3%</td>
<td></td>
</tr>
<tr>
<td>SB Universal TE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>100</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>0</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>SB Universal SE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>98%</td>
<td>97%</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>2</td>
<td>2%</td>
<td></td>
</tr>
</tbody>
</table>

**Conclusions:** Within the limits of this short term evaluation, there was no significant clinical difference between adhesives (p>0.05).

**3M ESPE Summary**

**Aim of Study:** To evaluate the one year clinical in-vivo performance of Scotchbond™ Universal Adhesive in both the total-etch and self-etch modes of use compared to Adper™ Scotchbond™ Multi Purpose Adhesive.

**Summary of Results:** There were no significant differences in the one year clinical performance for Adper™ Scotchbond™ Multi Purpose Adhesive and Scotchbond™ Universal Adhesive in either mode of use.

---

Results found in abstracts for Filtek™ Supreme Universal Restorative also apply to Filtek™ Z350 XT Universal Restorative.

Results found in abstracts for Scotchbond™ Universal Adhesive also apply to products registered under the following names: Single Bond Universal Adhesive and Adhesive EXL 759.
Scotchbond™ Universal Adhesive

Interfacial Chemistry of Universal Self-etch Adhesives After Prior Dentin Acid-Etching

C.T. TEGERDINE, X. YAO and Y. WANG, University of Missouri-Kansas City, Kansas City, MO

Objectives: Self-etch and total-etch adhesives bond composites to enamel and dentin, however, neither is sufficient to ideally bond to both dental substrates. Selectively total-etching enamel has been suggested to improve self-etch bonding ability to enamel, but because of its difficulty, prior acid etching of dentin occurs. Universal self-etch adhesives have been developed to work as total-etch or self-etch to address this issue. Little is known about the bonding interface of the new products with acid etched dentin. The purpose of this study was to examine the interfacial chemistry and morphology of a universal self-etch adhesive on dentin and compare how it performs to a total-etch adhesive.

Methods: Fifteen teeth were subjected to prior acid etching and then applied with Adper™ Single Bond Plus Adhesive, Scotchbond™ Universal Adhesive (without Rubbing) and Scotchbond™ Universal Adhesive (with Rubbing). Teeth were sectioned and examined using Raman microspectroscopy, differential Goldner’s trichrome staining and scanning electron microscopy.

Results: Scotchbond™ Universal Adhesive showed a significantly thicker interface (one-way ANOVA with Tukey-Kramer post hoc test, =0.05), a better penetration profile and similar hybrid layer morphology when compared to Adper™ Single Bond Plus Adhesive. A rubbing technique was found to be important for the application of Scotchbond™ Universal Adhesive; without rubbing caused the adhesive to de-bond and separate from dentin.

Conclusions: The results suggest that Scotchbond™ Universal Adhesive performed similarly to Adper™ Single Bond Plus Adhesive with no adverse effects from prior acid etching. The clinician does not have to be as accurate when performing selective enamel etching. Funded by UMKC SOD Summer Scholars Program.

3M ESPE Summary

Aim of Study: To evaluate the interfacial morphology to etched dentin when using Scotchbond™ Universal Adhesive compared to Adper™ Single Bond Plus Adhesive which is a traditional total-etch adhesive.

Summary of Results: Scotchbond™ Universal Adhesive provided for a significantly thicker interface to etched dentin than Adper™ Single Bond Plus when used with a rubbing motion, which is consistent the products instructions for use.
Objectives: To evaluate lithium disilicate glass-ceramic repair using separate hydrofluoric acid etching and silinization steps compared to a Universal Self-Etching Bonding agent using hydrofluoric acid etching only.

Methods: IPS e-max Press ceramic ingots (Ivoclar Vivadent) were sectioned into 52x5mm disks and mounted with resin into stainless steel rings. Products evaluated were Scotchbond™ Multi-Purpose Plus Adhesive (MP) (3M ESPE); Adper™ Scotchbond™ 1XT Adhesive (SB) (3M ESPE) and Scotchbond™ Universal Adhesive (SU) (3M ESPE). Ceramic disks were randomly divided into four groups of 13 disks each. All groups (52 disks) were prepared using 9% Hydrofluoric Acid (HF) (Ultradent) applied for 60 seconds, well rinsed, followed by Silane (SI) (Ultradent) application of 39 disks only (Groups A, B and C). For Group D (13 disks) no silane was applied. The bonding agents were applied to all disks and a Z100™ Restorative (3M ESPE) composite stub was bonded to each ceramic disk using an Ultradent jig. After allowing the bonds to mature for 12 hours at 35°C the test groups were thermocycled between 5–55°C (±1°C) for 2000 cycles with a dwell time of 15 seconds. The bonds were then stressed to failure using an Instron testing machine, crosshead speed of 0.5mm/minute.

Results: The composite bond strength for group C was significantly higher than for groups A, B and D. The composite bond strength for groups A, B and D were statistical comparable.

Conclusions: For the products evaluated and with-in the limitations of this study, the results showed that clinicians, when using SU for glass-ceramic repair, could achieve comparable bond strength to those achieved by products needing a separate saline application step. However, adding a silane step to SU could increase the bond strength to the glass-ceramic even further.

**3M ESPE Summary**

**Aim of Study:** To evaluate the silane effectiveness for Scotchbond™ Universal Adhesive to bond to lithium disillicate in comparison to other adhesive systems used in conjunction with a separate silane treatment application.

**Summary of Results:** Scotchbond™ Universal Adhesive was able to provide effective bond strengths to lithium disillicate without a separate silane application step.
Filtek™ Supreme Ultra Universal Restorative

Self-Polishing and Wear Characteristics of Universal Composite Materials
B.D. CRAIG1, G. KOBUSSEN2, J.L. KITTELSON2 and A.S. ABUELYAMAN1, 13M ESPE, Saint Paul, MN, 23M ESPE Dental Products, Saint Paul, MN

Objectives: The objective of this work was to evaluate the ability of composite materials to self-polish over the course of toothbrush abrasion and compare relative wear characteristics of the materials.

Methods: Five tiles each of six commercially available composite materials were roughened with 320 grit sandpaper to mimic a clinical burr. The initial gloss was taken of these samples and the samples were toothbrush abraded under fixed conditions for 6,000 strokes. The resulting gloss was then measured after brushing. Additionally, 3-body wear resistance was measured in micron loss for all of these composites and scanning electron micrograph images taken to evaluate the wear patterns and behavior of the composites.

Results:

<table>
<thead>
<tr>
<th>Composite</th>
<th>Lot#</th>
<th>Initial Gloss (StDev), 320 Grit Sandpaper</th>
<th>60º Gloss After 6000 Toothbrush Strokes (StDev)</th>
<th>3-Body Wear Depth at 200,000 Cycles, Microns (StDev)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paradigm™ NH (PNH) 3M ESPE</td>
<td>N488170</td>
<td>15.40 (0.84)</td>
<td>20.70 (2.58)</td>
<td>14.30 (0.42)</td>
</tr>
<tr>
<td>Venus™ Pearl (VP) Heraeus Kulzer</td>
<td>10023</td>
<td>13.56 (0.63)</td>
<td>28.78 (3.61)</td>
<td>36.50 (0.97)</td>
</tr>
<tr>
<td>Majesty™ ES-2 (MAJ) Kuraray</td>
<td>00010A</td>
<td>21.4 (2.64)</td>
<td>50.00 (3.07)</td>
<td>47.20 (1.59)</td>
</tr>
<tr>
<td>TPH™ Spectra LV (SLV) Dentsply</td>
<td>1302091</td>
<td>6.86 (0.71)</td>
<td>31.78 (9.43)</td>
<td>44.80 (1.64)</td>
</tr>
<tr>
<td>TPH™ Spectra HV (SHV) Dentsply</td>
<td>1306052</td>
<td>8.28 (1.03)</td>
<td>29.14 (10.46)</td>
<td>38.20 (0.61)</td>
</tr>
<tr>
<td>Filtek™ Supreme Ultra (FSU) 3M ESPE</td>
<td>N492108</td>
<td>19.56 (1.40)</td>
<td>55.42 (7.04)</td>
<td>14.90 (0.43)</td>
</tr>
</tbody>
</table>

Conclusions: When analyzed by ANOVA (P< 0.05), FSU and MAJ showed higher gloss after brushing than the remaining composites. In relative wear, FSU and PNH showed (P<0.05) statistically better wear characteristics than the other composites. Only FSU had a combination of high auto-polishing and low wear rates among the composites tested.

3M ESPE Summary

Aim of Study: Investigate the self-polishing and wear behavior of several composites under a tooth brush challenge.

Summary of Results: Self-polishing was evident on all composites after tooth brushing. Only Filtek™ Supreme Ultra Universal Restorative showed high auto-polishing and low wear.
Cusp Deformation as a Product of Shrinkage and Elastic Modulus

T.D. DUNBAR1, A.S. ABUELYAMAN1, K. DEDE2, B.D. CRAIG1, J.L. KITTELSON3 and R.H. HALVORSON1, 13M ESPE, Saint Paul, MN, 23M Deutschland GmbH, Seefeld, Germany, 33M ESPE Dental Products, Saint Paul, MN

Objectives: Compare polymerization shrinkage and elastic modulus as predictors of low polymerization shrinkage stress in resin-based composites (RBCs).

Methods: Polymerization shrinkage was determined through the bonded disk method (n=4). Elastic modulus was determined through three point bending flexural bar measurements (n=6). Polymerization shrinkage stress was measured via the aluminum cusp method through measuring the cusp deformation upon polymerization of a composite placed in a slot-shaped (4mm x 4mm x 8mm) artificial cavity (n=5). A variety of RBCs were chosen: posterior (P), universal (U), bulk fill (BF), flowable (F) and two-part (2P).

Results: Means with the same letter are statistically not different by ANOVA using Tukey’s comparison (p<0.05).

In a regression model where: deformation = A*shrinkage + B*e-modulus + C*shrinkage*e-modulus, only the interaction term was found to be statistically significant (p=0.046).

Only non-existent or weak correlations were found between shrinkage and deformation (R2=2%) or e-modulus and deformation (R2=38%). When shrinkage*e-modulus, however, is plotted against deformation, a good correlation is found (R2=76%).

Conclusions: Neither polymerization shrinkage nor e-modulus alone is a good predictor of polymerization shrinkage stress in RBCs. The interaction term (shrinkage*e-modulus) correlates well, however, with polymerization shrinkage stress over a wide variety of RBCs.

<table>
<thead>
<tr>
<th>Material</th>
<th>Type</th>
<th>Shrinkage (%)</th>
<th>E-Modulus (GPa)</th>
<th>Deformation (Microns)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filtek™ Bulk Fill Flowable Restorative (3M ESPE)</td>
<td>F</td>
<td>2.91 ± 0.04b</td>
<td>4.42 ± 0.15i</td>
<td>7.7 ± 0.2h</td>
</tr>
<tr>
<td>SureFil® SDR® Flow (Dentsply)</td>
<td>F</td>
<td>2.77 ± 0.02c</td>
<td>5.38 ± 0.10h</td>
<td>5.5 ± 0.2i</td>
</tr>
<tr>
<td>Tetric EvoCeram® (Ivoclar)</td>
<td>U</td>
<td>1.58 ± 0.03hi</td>
<td>6.70 ± 0.12g</td>
<td>7.21 ± 0.10h</td>
</tr>
<tr>
<td>Tetric EvoCeram® Bulk Fill (Ivoclar)</td>
<td>BF</td>
<td>1.80 ± 0.02f</td>
<td>8.09 ± 0.16f</td>
<td>8.7 ± 0.2g</td>
</tr>
<tr>
<td>Herculite® Ultra (Kerr)</td>
<td>U</td>
<td>2.26 ± 0.02f</td>
<td>8.2 ± 0.2f</td>
<td>12.5 ± 0.3ab</td>
</tr>
<tr>
<td>HyperFil™ (Parkell)</td>
<td>2P</td>
<td>3.10 ± 0.15a</td>
<td>9.2 ± 0.3e</td>
<td>12.7 ± 0.3a</td>
</tr>
<tr>
<td>TPH Spectra™ HV (Dentsply)</td>
<td>U</td>
<td>2.40 ± 0.06d</td>
<td>9.6 ± 0.3de</td>
<td>11.5 ± 0.3cde</td>
</tr>
<tr>
<td>Filtek™ LS Restorative (3M ESPE)</td>
<td>P</td>
<td>0.83 ± 0.06j</td>
<td>9.8 ± 0.2d</td>
<td>4.20 ± 0.17j</td>
</tr>
<tr>
<td>SonicFill™ (Kerr)</td>
<td>BF</td>
<td>1.76 ± 0.04fg</td>
<td>10.0 ± 0.4d</td>
<td>11.2 ± 0.3de</td>
</tr>
<tr>
<td>SureFil® High Density (Dentsply)</td>
<td>BF</td>
<td>1.80 ± 0.03f</td>
<td>11.1 ± 0.3c</td>
<td>11.9 ± 0.4bc</td>
</tr>
<tr>
<td>Alert® (Syncra)</td>
<td>BF</td>
<td>2.06 ± 0.04e</td>
<td>11.1 ± 0.3c</td>
<td>11.2 ± 0.2de</td>
</tr>
<tr>
<td>Filtek™ Z250 Universal Restorative (3M ESPE)</td>
<td>U</td>
<td>1.76 ± 0.01fg</td>
<td>11.3 ± 0.2bc</td>
<td>11.0 ± 0.3e</td>
</tr>
<tr>
<td>Filtek™ P60 Restorative (3M ESPE)</td>
<td>P</td>
<td>1.63 ± 0.03ghi</td>
<td>11.8 ± 0.4b</td>
<td>10.2 ± 0.2f</td>
</tr>
<tr>
<td>Quixx® (Dentsply)</td>
<td>BF</td>
<td>1.51 ± 0.03i</td>
<td>14.2 ± 0.4a</td>
<td>12.4 ± 0.2ab</td>
</tr>
<tr>
<td>GrandioSO® (Voco)</td>
<td>U</td>
<td>1.67 ± 0.04fg</td>
<td>14.4 ± 0.3a</td>
<td>12.6 ± 0.3a</td>
</tr>
<tr>
<td>x-tra fil® (Voco)</td>
<td>BF</td>
<td>1.63 ± 0.07ghi</td>
<td>14.4 ± 0.4a</td>
<td>11.7 ± 0.4cd</td>
</tr>
</tbody>
</table>

Conclusions: Neither polymerization shrinkage nor e-modulus alone is a good predictor of polymerization shrinkage stress in RBCs. The interaction term (shrinkage*e-modulus) correlates well, however, with polymerization shrinkage stress over a wide variety of RBCs.
Filtek™ Bulk Fill Flowable Restorative (cont.)

3M ESPE Summary

Aim of Study: Compare polymerization shrinkage and elastic modulus as predictors of low polymerization shrinkage stress in resin-based composites in a tooth deformation model.

Summary of Results: The interaction of volumetric shrinkage and flexural modulus was observed to correlate with shrinkage stress better than the individual properties alone.
Polymerization Conversion Change at Different Curing Depth for Bulk-Fill Composites

C. CAO1, G. KOBUSSEN1, D.L. ELMORE2, J.L. KITTELSON1 and J.D. OXMAN1, 13M ESPE Dental Products, Saint Paul, MN, 23M CRAL, Saint Paul, MN

Objectives: As more and more bulk-fill composites come to market, 4mm or higher curing depth becomes a great attracting feature. At the same time, questions on sufficient curing at the bottom of claimed depth of cure are frequently raised. Studies have been performed on bulk fill composites: some are more academic, some focus on clinical relevance. This research tries to study the conversion change from top to bottom of the claimed curing depth using Raman Spectroscopy, following the depth of cure method described in ISO4049:2009.

Methods: Materials used were Filtek™ Bulk Fill Flowable U (3M ESPE), SureFill® SDR™ flow U (Dentsply), Venus® Bulk Fill U (Heraeus Kulzer), x-tra base U (Voco), SonicFill™ A1(Kerr) and Tetric EvoCeram® Bulk Fill IVW (Ivoclar Vivadent). LED curing lights were used according to manufacture instructions (SonicFill™: 1200 mW/cm², 20 seconds; all others: 600 mW/cm², 20 seconds). Samples were cured inside a customer-made hemi-cylinder stainless steel mold with detachable plate. Raman spectra were recorded at various curing depths and polymerization conversion was calculated accordingly.

Results: The conversion at several curing depth for different materials was listed in the table below. The ratio of conversion at bottom of curing depth vs. top was highlighted in blue color. This set of data was analyzed in Minitab® using Tukey’s method.

<table>
<thead>
<tr>
<th>Curing Depth (mm)</th>
<th>Filtek™ Bulk Fill Flowable</th>
<th>SureFill® SDR™ Flow</th>
<th>Venus® Bulk Fill</th>
<th>x-tra base</th>
<th>Tetric EvoCeram® Bulk Fill</th>
<th>SonicFill™</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (Top)</td>
<td>70.2 (1.62)</td>
<td>84.0 (2.01)</td>
<td>76.6 (0.69)</td>
<td>67.3 (0.70)</td>
<td>68.8 (1.40)</td>
<td>82.6 (0.61)</td>
</tr>
<tr>
<td>2 (Middle)</td>
<td>70.4 (0.47)</td>
<td>84.1 (2.18)</td>
<td>76.7 (0.32)</td>
<td>65.9 (0.66)</td>
<td>63.1 (2.87)</td>
<td>77.1 (1.19)</td>
</tr>
<tr>
<td>4 or 5* (Bottom)</td>
<td>66.7 (1.46)</td>
<td>78.9 (0.87)</td>
<td>74.7 (0.98)</td>
<td>62.1 (1.79)</td>
<td>58.5 (2.57)</td>
<td>64.7 (2.06)*</td>
</tr>
</tbody>
</table>

*Bottom/Top

95.0% 93.9% 97.6% 92.3% 85.0% 78.3%

Grouping (Tukey’s Method)

<table>
<thead>
<tr>
<th>Filtek™ Bulk Fill Flowable</th>
<th>SureFill® SDR™ Flow</th>
<th>Venus® Bulk Fill</th>
<th>x-tra base</th>
<th>Tetric EvoCeram® Bulk Fill</th>
<th>SonicFill™</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>a</td>
<td>a</td>
<td>a</td>
<td>b</td>
<td>b</td>
</tr>
</tbody>
</table>

*SonicFill samples were cured with a higher power curing light according to their instruction and the claimed depth is 5mm.

Conclusions: When the ISO4049:2009 method was used, the bottom/top degree-of-conversion ratios for the four flowable bulk fill composites in this study were statistically in one group, with values all above the 90% threshold. SonicFill™ and Tetric EvoCeram® Bulk Fill were in another group with lower bottom/top conversion ratios, both below the 90% threshold.

3M ESPE Summary

Aim of Study: Investigate the depth of cure of several bulk fill composites via Raman Spectroscopy from samples prepared using the ISO 4049 standard for depth of cure.

Summary of Results: Filtek™ Bulk Fill Flowable Restorative and the three other flowable bulk fills achieved at least 90% conversion at their stated depths of cure. Neither of the sculptable bulk fill composites was able to achieve the 90% conversion threshold at their stated depth of cure.

Reprinted with permission from the Journal of Dental Research, J Dent Res 93 (Spec Iss A): 181
https://jdr.carexf.com/jdr/43am/webprogram/start.html
Filtek™ Bulk Fill Flowable Restorative

Non-Contact Phase Microscopy Provides Nanoscale Measurement of Composite Shrinkage

M.C. PRAGER, New York University College of Dentistry, New York, NY, M.C. PIERCE, Rutgers, The State University of New Jersey, Piscataway, NJ and M.S. WOLFF, New York University, New York, NY

Objectives: To test the capability of spectral domain phase microscopy (SDPM) as part of a high-compliance system to quantify displacement due to polymerization shrinkage of composite.

Methods: Aluminum blocks (n=13) milled with simulated MOD cavities (6mm x 8mm x 4mm) and 2mm thick cusps were sandblasted (50mm Al2O3) internally. Mylar-on-aluminum strips formed passive matrices and blocks were secured at their bases in a 3-axis positioning stage (Newport 460A series). The following bonding agents/composites were tested: ExcITE F/Tetric EvoCeram Bulk Fill (XF/EC, Ivoclar, n=6); Scotchbond™ Universal Adhesive/Filtek™ Bulk Fill Flowable Restorative (SU/FT, 3M ESPE, n=6). Bonding agents were applied to MOD cavities and cured with UltraLume LED5 (LED, Ultradent) @530mW/cm²x10s fixed 2mm above the blocks. Blocks were positioned with one cusp wall facing the SPDM optical beam, approximately 1mm away from a reference cover glass (Figure 1). EC and FT were placed in single 4mm increments and cured @530mW/cm²x20s. One block with no bonding agent or composite acted as control. Single cusp displacement was measured by SDPM at the block midpoint, 0.5mm from top of cusp, from onset of illumination at five second intervals for a total duration of 10 minutes.

Results: Measurement of the control block demonstrated SDPM baseline stability of 6.4nm over the 10 minute measurement period. Composites EC and FT showed single cusp displacements of 2044 ± 316nm and 1586 ± 359nm respectively. A two-sided t-test indicated that the mean displacements for the EC and FT groups were significantly different (p=0.04).

Conclusions: Spectral domain phase microscopy offers a highly sensitive, non-contact method for studying dental composite shrinkage via cuspal deflection in a model system. By scanning the illumination beam, the technique can be expanded from a point measuring method to monitor time-dependent deflections over complex surfaces.

3M ESPE Summary

Aim of Study: Spectral domain phase spectroscopy was used to measure the deflection during and after polymerization of two bulk fill composite materials bonded within a slot preparation of an aluminum mold.

Summary of Results: Spectral domain phase microscopy provides a sensitive technique for non-contact measurement of the strain produced during polymerization of composite in an aluminum block. Filtek™ Bulk Fill Flowable Restorative induced less deformation of the aluminum block compared to Tetric Evo Ceram Bulk Fill.
The Effect of Hydrochloric Acid on Resin Composite Hardness

M.J. GERMAN, G.I. MCCRACKEN, M.M. ZAMAN and R.W. WASSELL, Newcastle University, Newcastle-upon-Tyne, England

Objectives: Patients with persistent acid reflux, regurgitation and vomiting often have severe erosion of the surfaces of teeth due to exposure to stomach acid (HCl). Consequently, any permanent restorative material used to repair these teeth needs to be resistant to damage by HCl. We have studied a range of commercially available composites to establish the effect HCl exposure has on hardness.

Methods: Six commercially available composites (Table 1) were selected to represent the major monomer systems available. Disc specimens (diameter=12mm, thickness=3mm, n=20) were made for each material in custom-made PMMA moulds. Specimens were polymerised for 40 seconds on top and bottom faces (Coltolux LED, 500mW/cm²) and then left to condition for 28 days in PBS at 37°C. Next Martens baseline hardness was measured (Zwick Z 2.5) for all specimens (five indents per disc) and specimens were divided into five groups (n=5), relating to either differing concentrations of HCl (pH1–2.5) or PBS (pH7.4). After storage for another 28 days at 37°C hardness was measured on the opposite face and the % change calculated.

Results: There were significant hardness differences between all composites at baseline (table 1). Four of the composites exhibited a significant decrease in hardness after exposure to pH1 HCl, of which two also exhibited a significant decrease in hardness for pH1.5. No significant differences were found after exposure to HCl at pH above 1.5 or exposure to PBS. The composites with the best performance used either a silorane system or a mix of Bis GMA, UDMA and BisEMA. Composites containing mainly UDMA appeared to soften more at pH1 and 1.5.

Conclusions: While we have not taken filler type or concentration into account, these results suggest that composites in which the main monomer is UDMA may be more susceptible to HCl erosion than those containing Bis-GMA.

3M ESPE Summary

Aim of Study: Acid reflux causes severe erosion of teeth due to stomach acids. This study investigated the erosive capability of hydrochloric acid solutions on several composite restorative materials.

Summary of Results: Four of the six composites tested showed significant decrease in surface hardness with HCl solutions of 1.5 pH or lower. Only Filtek™ Silorane Low Shrink Posterior Restorative and Filtek™ Z250 Universal Restorative showed little hardness change with any of the pH solutions studied.
**Filtek™ Z550 Nano Hybrid Universal Restorative**

**12-Months Clinical Comparison of Two Resin Composites on Diastema Closure**

Z.B. KUTUK¹, E. ERGIN², S. GURGAN², F. YALCIN CAKIR¹ and S.S. OZTAS¹, ¹Hacettepe University, Ankara, Turkey, ²Hacettepe University, School of Dentistry, Ankara, Turkey, ³Hacettepe University, Ankara, Turkey

**Objectives:** To evaluate the esthetic, functional and biological clinical performance of two nano hybrid resin composite systems used for anterior diastema closure at 12-months.

**Methods:** Twenty-three patients with anterior midline or multi-diastema problem were enrolled in this study. Nano hybrid resin composite systems to be used on each patient were randomly selected. Thirty-seven teeth of 10 patients were restored with Filtek™ Z550 Nano Hybrid Universal Restorative (3M ESPE) in combination with Adper™ Single Bond 2 (3M ESPE) etch&rinse adhesive; whereas 39 teeth of 13 patients were restored with Charisma-Diamond (Heraeus Kulzer) in combination with Gluma 2 Bond (Heraeus Kulzer) etch&rinse adhesive by two operators. Esthetic (Surface Luster, Surface/Margin Staining, Color Match and Translucency, Esthetic Anatomical Form), Functional (Fracture of Material and Retention, Marginal Adaptation, Patient’s View) and Biological (Periodontal Response, Adjacent Mucosa, Oral & General Health) properties of the restorations were evaluated at baseline, 6- and 12-months using FDI Criteria establishing a score-range of 1–5 (1-Clinically excellent/very good, 2-Clinically good, 3-Clinically sufficient/satisfactory, 4-Clinically unsatisfactory and 5-Clinically poor) by two independent examiners. The results were evaluated using the Pearson Chi-Square (p=0.05).

**Results:** At 12-months, 23 patients were evaluated. Two Filtek™ Z550 Nano Hybrid Universal Restorative restorations (5.4%) and five Charisma-Diamond (12.8%) restorations exhibited minor surface staining (Score 2). The surface luster of three Charisma-Diamond restorations was scored as two. Three Filtek™ Z550 Nano Hybrid Universal Restorative restorations (8.1%) and one Charisma-Diamond restoration (2.6%) were scored as two with minor irregularities in marginal adaptation. However, there were no significant differences between two restorative materials for surface/marginal staining, surface luster and marginal adaptation (p>0.05). All the restorations in both groups were clinically excellent (Score 1) for the rest of the esthetic, functional and biological properties assessed.

**Conclusions:** Both nano hybrid resin composite systems revealed esthetically, functionally and biologically good clinical performance when used for diastema closure at 12-months.

**3M ESPE Summary**

**Aim of Study:** Evaluate the 12-month clinical performance of two nano hybrid restoratives for diastema closure.

**Summary of Results:** Filtek™ Z550 Nano Hybrid Universal Restorative was scored excellent for all restorations in 10 of the 12 criteria evaluated. Minor irregularities were noted in two restorations for surface staining and three restorations for marginal adaptation.
The Effects of Toothbrush Abrasion on Resin Composite Materials

T.P. BERRY¹, T. TAKAMIZAWA², W.W. BARKMEIER¹ and M. NUNN¹, ¹Creighton University, School of Dentistry, Omaha, NE, ²Nihon University, Tokyo, Japan

**Objectives:** Toothbrush abrasion may affect the esthetic and functional characteristics of dental restorative materials. The purpose of this study was to examine the parameters of wear, surface roughness and gloss, following toothbrush abrasion of resin composites.

**Methods:** Twelve specimens each were fabricated for testing in custom fixtures with a cylindrical-shaped cavity 4.5mm in diameter and 4mm in depth for testing using three materials: 1) Filtek™ Supreme Ultra Universal Restorative [SU] (3M ESPE); 2) G-aenial Universal Flo [GF] (GC); and 3) Venus Diamond [VD] (Heraeus Kulzer). The specimens were polished to a 4,000 grit surface by wet grinding with carbide papers. Baseline measurements were made for: a) gloss (Novo-Curve Gloss Meter); b) surface roughness (Proscan 2100) using ISO 4288-1996 recommendations; and c) surface contour (Proscan 2100). The specimens were subjected to 100,000 cycles in a toothbrush machine (165 gram load) using Lactona Soft M 39 nylon brushes in a 1:1 water/toothpaste slurry (Colgate Total Mint Paste). Test measurements after toothbrushing were recorded for gloss units [GU], surface roughness [Ra (µm)] and wear [mean facet depth (µm) and volume loss (mm³)]. Wear was determined using AnSur 3D software. An ANOVA and Tukey’s posthoc test was used for wear data analysis and an ANCOVA was conducted on final GU and Ra values with baseline GU and Ra measures as covariates. Multiple comparisons of LS means were conducted using Bonferroni.

**Results:** The ANOVA and ANCOVA showed a significant effect (p<0.001) for material. SU exhibited significantly less (p<0.05) wear than GF and VD. SU exhibited significantly higher gloss (GU) before and after toothbrushing with GF and VD being similar in GU after. VD had the greatest surface roughness before, while SU and VD exhibited a similar Ra after. The results are summarized in Tables 1–2.

**Conclusions:** SU was superior in GU, Ra and wear resistance after exposure to toothbrushing.

**3M ESPE Summary**

**Aim of Study:** Compare wear characteristics and polish retention of three universal composites subjected to toothbrush abrasion.

**Summary of Results:** Filtek™ Supreme Ultra Universal Restorative showed significantly less wear and significantly higher polish retention than Venus Diamond and G-aenial Universal Flo after 100,000 cycles of toothbrush abrasion.
Time–Dependent Mechanical Behaviors of Dental Class II Restorations

S. CHUANG, X. HONG and T.Y. CHEN, National Cheng Kung University, Tainan, Taiwan

Objectives: To investigate the mechanical responses of class II restorations restored by different resin composites by experimental measurements and a finite element analysis (FEA).

Methods: Forty intact extracted molars were mounted and prepared with a class II MOD cavity (4(W) × 4(H) mm). These teeth were divided into four groups and then restored with one of four techniques: a microhybrid composite Z250 filling, Z250; a packable composite P60 filling, P60; Z250 filling with Z350-flowable lining, Z250/F; and P60 filling with Z350-flowable lining, P60/F. After restoration, these teeth received a static loading test by applying a force of 200 N for one hour and were kept observation for another hour after removal of the load. During the test, the restorations were photographed through a microscope. A digital-image-correlation (DIC) program Vic-2009 was used to calculate the full-field deformation, accordingly to obtain the strains. A viscoelastic FEA was executed to study the stress states of different composite restorations.

Results: During the static test, the lining groups showed greater strains than groups without linings did and their strains increased significantly with time. Z250/F showed the greatest strain especially on the cavity bottom. After removal of loading for one hour, all groups showed nearly-complete strain recovery. The analytic results of FEA showed comparable strains to their respective experimental groups. The lining groups showed greater creep strain than groups without lining. For these groups, the stress was concentrated on the middle of restorations but was low on the cavity floor.

Conclusions: The viscoelastic property of resin composites may affect the strain and creep strains of the composite restorations. The use of low modulus lining materials significantly increased the creep strain of the whole restorations but decreased the stress concentration at the cavity floor.

3M ESPE Summary

Aim of Study: Digital image correlation and viscoelastic finite element analysis was used to study the mechanical behavior of restorations prepared with and without a flowable liner.

Summary of Results: Flowable liner was observed to increase the creep strain of the loaded restoration but decreased the stress at the cavity floor.
Concise™ Composite

Caries Preventive Effect of Glass Ionomer Sealant in Primary Molars

A. PHONGHANYUDH, O. BOONYAKIATI and S. NAKORNCHAI, Mahidol University, Bangkok, Thailand

Objectives: To evaluate the caries preventive effect of glass ionomer cement as a sealant over primary molars with no or enamel caries after 12 months.

Methods: Seventy-four pre-school children, aged 3–5 years, participated in a randomized, split-mouth, clinical trial. Pit and fissure caries were evaluated before sealing and after 12 months using ICDAS. Teeth with scores less than three were selected. Two-hundred and seventy-two molars were randomly assigned into two treatments; (1) glass ionomer sealant (Fuji VII) and (2) resin sealant (Concise™ Composite). After 12 months, teeth with partial or total loss of sealant were evaluated for the changes of caries status over the pits and fissures and categorized as “No change”, “Progression” and “Remission”. The teeth with complete retention of sealant were also categorized as “No change”.

Results: After 12 months, 128 teeth were available for evaluation. Resin sealant performed better in terms of retention. In the glass ionomer group; complete retention, partial loss and total loss were 24.2%, 47.7% and 28.1% respectively. In the resin group; complete retention, partial loss and total loss were 61.7%, 32.8% and 5.5% respectively. There was a highly significant difference in retention between both materials (p<0.001). In glass ionomer group, the percentage of “Progression” “No change” and “Remission” were 4.7%, 87.5% and 7.8% respectively. In resin group, the percentage of “Progression”, “No change” and “Remission” were 3.9%, 93.8% and 2.3%. There was no difference in the percentage of the occurrence of caries between two groups (p>0.05).

Conclusions: Complete retention of resin sealant was higher than glass ionomer sealant. Glass ionomer sealant and resin sealant can effectively prevent caries in primary molars.

3M ESPE Summary

Aim of Study: To compare the caries preventive effect of a glass ionomer cement used as a sealant to a resin sealant (Concise™ Composite) over primary molars with no or enamel caries after 12 months.

Summary of Results: Concise™ Composite performed statistically significant better in terms of retention than the glass ionomer cement. The occurrence of caries in the Concise™ Composite group was slightly lower but not significant. Glass ionomer sealant and resin sealant like Concise can effectively prevent caries in primary molars.
Different Finishing/Polishing Systems’ Effects on Surface Roughness/Hardness of Restorative Resins

B. AYDIN1, A.R. YAZICI1, S. KARAHAN2 and S.A. ANTONSON3, 1Hacettepe University, School of Dentistry, Ankara, Turkey, 2Hacettepe University, School of Medicine, Ankara, Turkey, 3School of Dental Medicine, University at Buffalo, State University of New York, Buffalo, Buffalo, NY

Objectives: To evaluate the effect of different finishing/polishing (F/P) systems on surface roughness and hardness of different restorative resin.

Methods: Three restorative resins were investigated: a low shrink posterior restorative, Filtek™ Silorane Low Shrink Posterior Restorative; a nano-hybrid composite, Tetric EvoCeram Bulk Fill (Ivoclar); a nano-ceramic composite, Ceram-X Mono (Caulk). Forty disc-shaped specimens (10mm in diameter, 2mm thick) from each material were prepared under Mylar strip polymerization. Ten specimens per group received no F/P (control). The rest of the specimens were randomly divided into three groups according to finishing/polishing systems; Enhance/PoGo (Dentsply), Astropol/Astrobrush (Ivoclar), Sof-Lex™ Spiral Finishing and Polishing Wheels (3M ESPE). All F/P systems were applied according to the manufacturers’ instructions after being ground wet with 320-grid SiC paper. Surface roughness (Ra) was assessed using contact profilometer and surface hardness was assessed using Vickers hardness device (load 500g; dwell time 15 seconds). The data were analyzed using two-way ANOVA and Bonferroni test (p<0.05).

Results: Compared to Mylar, F/P systems caused an increase in surface roughness of only Ceram-X Mono specimens (p<0.05). No significant differences among the F/P systems were found for surface roughness of Tetric EvoCeram Bulk Fill and Ceram-X Mono (p>0.05). Filtek™ Silorane Low Shrink Posterior Restorative exhibited the smoothest surface with Spiral Wheels, while no significant differences were found between Enhance/PoGo and Astropol/Astrobrush. Astropol/Astrobrush produced a statistically similar surface roughness on three restoratives (p>0.05). While the lowest roughness values were recorded with Spiral Wheels on Filtek Silorane (p<0.05), Enhance/PoGo produced smoother surface in Tetric EvoCeram Bulk Fill (p>0.05). All F/P groups had higher hardness than Mylar strip groups (p<0.05). Significant differences in surface hardness were found among F/P systems in Filtek™ Silorane Low Shrink Posterior Restorative group (p<0.05). In Tetric EvoCeram Bulk Fill and Ceram-X Mono, Spiral Wheels caused statistically higher hardness values than Astropol/Astrobrush and Enhance/PoGo (p<0.05).

Conclusions: The roughness and hardness of restorative materials differ according to the F/P systems and their effects seems to be material dependent.

3M ESPE Summary

Aim of Study: To evaluate the finishing and polishing effectiveness for various systems, including Sof-Lex™ Spiral Finishing and Polishing Wheels, on different composites by measuring surface roughness after treatment.

Summary of Results: The Sof-Lex™ Spiral Finishing and Polishing Wheels were effective relative to the other commercial systems.
Sof-Lex™ Spiral Finishing and Polishing Wheels

Polishing Performance of Five One-Step Instruments versus Sof-Lex™ Spiral Wheels

D.W. JACOBS1, B.A. SHUKLA1, C.A. SIGURDSON1 and J.L. KITTELSON2, 13M ESPE, Saint Paul, MN, 23M ESPE Dental Products, Saint Paul, MN

Objectives: The polishing performance of the Sof-Lex™ Spiral Finishing and Polishing Wheels (3MSS) was compared to five competitive one-step finishing and polishing systems (OptraPol® NG, ONG, Ivoclar Vivadent), (Maximus, MAX, Kenda), (ComposiPro™, CPR, Brasseler), (NTI® PDQ2®, PDQ2, Axis), (Opti1Step™, O1S, Kerr), for roughness, gloss and scratch removal (via SEM) on Filtek™ Supreme Ultra (FSU) nanocomposite.

Methods: Fully cured FSU 10mm x 15mm composite specimens were ground flat, roughened with a Brasseler (#0050244U0) fine diamond instrument (FD) and then manually finished and polished with each finishing and polishing system per the manufacturer’s instructions. Gloss 60 degree (GU), average roughness Ra and RzDIN (microns) were measured for each system with a Rhopoint Novo-Curve™ glossmeter and Veeco Dektak® 6M contact profiler, respectively. SEM (100X) images were generated for all groups after polishing to inspect for residual scratches and marks from the fine diamond.

Results: Mean (std dev) Gloss, Roughness (Ra), Roughness (RzDIN) and Tukey statistical analysis (p=0.05) rankings are listed in the table below (n=4).

<table>
<thead>
<tr>
<th></th>
<th>3MSS</th>
<th>ONG</th>
<th>O1S</th>
<th>MAX</th>
<th>CPR</th>
<th>PDQ2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gloss (GU)</td>
<td>83.4 (5.0)</td>
<td>78.7 (5.4)</td>
<td>68.8 (10.2)</td>
<td>38.8 (1.5)</td>
<td>32.7 (8.6)</td>
<td>41.7 (12.8)</td>
</tr>
<tr>
<td>Tukey Rank-GU</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>B</td>
<td>B</td>
<td>B</td>
</tr>
<tr>
<td>Roughness (Ra)</td>
<td>0.15 (0.03)</td>
<td>0.26 (0.08)</td>
<td>0.60 (0.06)</td>
<td>1.22 (0.45)</td>
<td>1.14 (0.37)</td>
<td>1.13 (0.21)</td>
</tr>
<tr>
<td>Tukey Rank-Ra</td>
<td>A</td>
<td>A</td>
<td>AB</td>
<td>C</td>
<td>BC</td>
<td>BC</td>
</tr>
<tr>
<td>Roughness (RzDIN)</td>
<td>0.60 (0.07)</td>
<td>1.73 (0.52)</td>
<td>5.01 (0.94)</td>
<td>8.70 (1.68)</td>
<td>7.67 (1.62)</td>
<td>7.78 (1.02)</td>
</tr>
<tr>
<td>Tukey Rank-RzDIN</td>
<td>A</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td>Residual FD Marks</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Conclusions: None of the one-step instruments evaluated removed the scratches created by a fine diamond instrument as effectively as the Sof-Lex™ Spiral Finishing and Polishing Wheels (3MSS). Smoother surfaces (statistically lower Ra & RzDIN values) were obtained with 3MSS and ONG than with O1S, MAX, CPR and PDQ2. Higher gloss values were obtained with 3MSS, ONG and O1S than with MAX, CPR and PDQ2.

3M ESPE Summary

Aim of Study: To measure the polishing performance of the Sof-Lex™ Spiral Finishing and Polishing Wheels compared to competitive one-step finishing and polishing systems.

Summary of Results: The Sof-Lex™ Spiral Finishing and Polishing Wheels were able to obtain smoother and higher gloss surfaces compared to the one-step systems.
Evaluation of 4% Articaine with Different Epinephrine Concentrations for Infiltration-Anesthesia

P.W. KÄMMERER, Harvard Medical School, Harvard University, Cambridge, MA, J. SEELING, Dental Private Praxis, Mannheim, Germany and M. DAUBLÄNDER, Dental Surgery Outpatient Clinic, University Medical Center Mainz, Germany

Objectives: The association between epinephrine concentrations and efficacy of infiltration anesthesia with Articaine 4% is not studied in detail yet. Therefore, the aim of the study was a first systematic comparative clinical evaluation of anesthetic efficacy of five 4% articaine solutions with and without epinephrine in pulpal anesthesia after infiltration in the upper jaw.

Methods: In a randomized, double-blinded cross-over study, in 10 volunteers, infiltration in the frontal maxilla with five different solutions (4% articaine + epinephrine 1:100,000, + epinephrine 1:200,000, + epinephrine 1:300,000, + epinephrine 1:400,000, without epinephrine) was conducted. Via electronic pulp tester, onset, utilization time, time to recede as well as the surface integral under the time-effect curve were calculated. Additionally, cardiovascular parameters (heart rate, blood pressure, oxygen saturation) and post-experimental soft tissue anesthesia were examined.

Results: Onset as well as time to recede was not influenced by the epinephrine concentration (p>0.1). Though, when using the epinephrine-free agent, time to recede was significant shorter (p<0.01). With decreasing epinephrine concentration, duration of pulpal anesthesia as well as total anesthetic efficacy declined. Shortest time of anesthesia and lowest anesthetic efficacy was seen for the solution without epinephrine (all p<0.002) which gave sufficient pain relieve in 50% of cases only. No associations between the local anesthetic drug and cardiovascular parameters were seen. Soft tissue anesthesia was significant shorter when using no epinephrine (p<0.001).

Conclusions: In this study, the substantial benefit of the vasoconstrictor in dental infiltration anesthesia by means of prolongation and deeper therapeutic deafness in a dose dependent manner could be proven. Though, even when using epinephrine-reduced agents, a safe anesthesia was possible. The use of the solution without epinephrine resulted in a distinct limitation of utilization time and efficacy.

3M ESPE Summary

Aim of Study: To evaluate the influence of 4% articaine with different and without adrenaline on the efficacy on pulpal anesthesia using infiltration technique.

Summary of Results: With decreasing epinephrine concentration, duration of pulpal anesthesia as well as total anesthetic efficacy declined. Shortest time of anesthesia and lowest anesthetic efficacy was seen for the solution without epinephrine. There is a substantial benefit when using a vasoconstrictor for infiltration technique by means of a longer and deeper anesthesia. Ubistesin™ 1/400,000 showed that even when using epinephrine-reduced agents, a safe anesthesia is possible.
Influence of Air/Vinylpolysiloxane on Residual Layers of Temporization Materials

M. TSAO and R.D. PERRY, Tufts University School Of Dental Medicine, Boston, MA

Objectives: To compare the thickness of residual layers created by temporization crown and bridge materials against air and one alginate substitute VPS impression material (Imprint™ 4 Preliminary VPS Penta™ Impression Material) materials in Penta™ delivery system. Less residual layer may translate to a product with better handling characteristics and more aesthetic provisionals.

Methods: Seven temporary materials were selected to test the thickness of residual layers against air and VPS impression material dispensed with a Pentamix™ 3 Automatic Mixing Unit (3M ESPE). Temporary materials tested were: Integrity® Fluorescence-IN (Dentsply), Luxatemp Star-LU (DMG), Protemp™ 4-PR (3M ESPE), Visalys Temp-VI (Kettenbach), PreVISION®-PV (Heraeus), Structur 3-VO (VOCO), Structur Premium-ST (VOCO). Six samples per group (N=6) of impression material tiles 3cm x 3cm x 3mm were created. Each temporary material was dispensed according to manufacturers’ directions into Delrin-rings (d=20mm; h=3.5mm) mounted on either impression tiles or glass slides (for air).

Samples were removed from tiles, slides and ring after setting 15 minutes at room temperature. Samples were weighed, first with the residual layer and again after removing residual layer with isopropranol. For VPS materials, impression tiles were also weighed before and after removing residual layers. Weight differences were calculated.

Results: Data was analyzed using One-way ANOVA with Fischer test, achieving 95% confidence interval. Summary of results, mean values and standard deviations calculated. Means in each column with same letters (A–E) are statistically the same.

<table>
<thead>
<tr>
<th>Material</th>
<th>Code</th>
<th>Air (mg/cm²)</th>
<th>Air (mg/cm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integrity Fluorescence (Dentsply)</td>
<td>IN</td>
<td>2.66 (±0.28)</td>
<td>1.8 (±0.21)</td>
</tr>
<tr>
<td>Luxatemp Star (DMG)</td>
<td>LU</td>
<td>4.00 (±0.19)</td>
<td>2.33 (±0.32)</td>
</tr>
<tr>
<td>Protemp™ 4 Temporization Material (3M ESPE)</td>
<td>PR</td>
<td>2.59 (±0.16)</td>
<td>1.49 (±0.20)</td>
</tr>
<tr>
<td>Visalys Temp-VI (Kettenbach)</td>
<td>VI</td>
<td>4.34 (±0.32)</td>
<td>3.52 (±0.59)</td>
</tr>
<tr>
<td>PreVISION (Heraeus Kulzer)</td>
<td>PV</td>
<td>4.96 (±0.18)</td>
<td>5.33 (±0.53)</td>
</tr>
<tr>
<td>Structur 3 (VOCO)</td>
<td>VO</td>
<td>4.32 (±0.26)</td>
<td>3.29 (±0.45)</td>
</tr>
<tr>
<td>Structur Premium (VOCO)</td>
<td>ST</td>
<td>6.18 (±0.27)</td>
<td>4.99 (±0.57)</td>
</tr>
</tbody>
</table>

Table 1: Smear layer on different temporization materials with air and Imprint™ 4 Preliminary VPS Penta™ Impression Material.

*PreVISION VPS-Garant samples tested twice due to a high standard deviation, but yielded same results. Second group results used for statistical analyses.
Imprint™ 4 Preliminary VPS Preliminary Impression Material, Protemp™ 4/Plus Temporization Material (cont.)

Figure 1: Smear layer on different temporization materials against air and Imprint™ 4 Preliminary VPS Penta™ Impression Material.

Conclusions: Across all seven provisional materials, thicknesses of residual layers were lowest against VPS and highest against air. PreVISION had thickest residual layer on VPS material. StructurPremium had thickest residual layer against air and with VPS. Protemp™ 4 Temporization Material and Integrity produced the least amount of residual layer at all conditions.

3M ESPE Summary

Aim of Study: This study compared the smear layer formation upon setting on different temporization materials against air and against Imprint™ 4 Preliminary VPS Penta™ Impression Material a newly introduced VPS preliminary impression.

Summary of Results: Protemp™ 4/Plus Temporization Material had the lowest smear layer against air and against Imprint™ 4 Preliminary VPS Penta™ Impression Material. Also, the smear layer on Protemp™ 4/Plus Temporization Material and most other temporization materials was significantly lower when Imprint™ 4 Preliminary VPS Penta™ Impression Material was used as a matrix. A low smear layer will require less polishing of the temporary.
Elastic Recovery of Light-Bodied Impression Materials at Different Working Times

L. FOX, R.D. PERRY and G. KUGEL, Tufts University School of Dental Medicine, Boston, MA

Objectives: To compare the elastic recovery behavior of five commercially available quick setting impression materials with a newly introduced Super Quick vinylpolysiloxane (VPS) material Imprint™ 4 VPS Impression Material (3M ESPE) and evaluate the effect of varied working times.

Methods: Six groups (n=10 each group) of quick setting light body materials were analyzed for elastic recovery according to ISO4823:2000 standards (ADA No.19, 2004). Materials: 3M™ ESPE™ Imprint™ 4 VPS Impression Material (IP4), Dentsply Aquasil Ultra XLV (XLV), Heraeus Flexitime Xtreme Correct Flow (FTX), Kerr Take 1 Advanced™ (T1A), Panasil Initial-X-lightFast (XLF) and GC EXA’lence Light Body™ (EXA). After a working time of one minute (according to ISO) the mold was placed into a 35°C water bath and allowed to set according to manufacturer’s directions; total set time (XLV, T1A, XLF, EXA) or fixed intra-oral set time (IP4, FTX). A second experiment was performed with a shortened working time of 30 seconds (non-ISO standard).

Results: One-way ANOVA and Tukey tests were performed on percent recovery (P<0.05). Results are shown below.

<table>
<thead>
<tr>
<th>Working Time</th>
<th>1 Minute (acc. to ISO 4823:2000)</th>
<th>30 Seconds</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Code</td>
<td>Value (% Recovery)</td>
</tr>
<tr>
<td>Imprint™ 4 VPS Super Quick Impression Material</td>
<td>IP4</td>
<td>99.65 (0.033)ab</td>
</tr>
<tr>
<td>Aquasil Ultra XLV Fast Set</td>
<td>XLV</td>
<td>99.41 (0.064)c</td>
</tr>
<tr>
<td>Take 1 Advanced Super Fast</td>
<td>T1A</td>
<td>99.7 (0.081)ab</td>
</tr>
<tr>
<td>Panasil Initial X-Light Fast</td>
<td>XLF</td>
<td>99.61 (0.077)cde</td>
</tr>
<tr>
<td>Exa’lence Light Body Fast Set</td>
<td>EXA</td>
<td>99.11 (0.14)ab</td>
</tr>
<tr>
<td>Flexitime Xtreme Correct Flow</td>
<td>FTX</td>
<td>99.4 (0.16)c</td>
</tr>
</tbody>
</table>

Table 1: Elastic recovery from deformation of elastomeric impression materials at standard test conditions with one minute working time and with a reduced working time of 30 seconds. Means that do not share a letter are statistically different.

Figure 1: Elastic recovery from deformation of elastomeric impression materials at standard test conditions with one minute working time and with a reduced working time of 30 seconds.

continued on next page >
Imprint™ 4 VPS Impression Material (cont.)

Conclusions: All materials performed above the minimum (96.5%). ISO standards for recovery. At one minute IP4 showed similar elastic recovery to T1A and XLF. At 30 seconds IP4 showed similar recovery to only T1A. Within the materials with fixed intra-oral set time, IP4 showed no significant difference between the two working times, while FTX was immeasurable at reduced working time. Within the materials with total set time, XLV showed a statistical improvement of elastic recovery with shorter working time while all other groups showed no significant difference.

3M ESPE Summary

Aim of Study: The study analyzed how a reduced working time influences the ISO measurement for Elastic Recovery from Deformation of elastomeric impression materials.

Summary of Results: Reduced working time did not have a negative effect on elastic recovery from elongation of the tested impression materials with the exception of FTX that was not measurable at a reduced working time. Imprint™ 4 Super Quick Impression Material with the shortest intra-oral setting time showed high elastic recovery from deformation at both times which indicated that the given intra-oral setting time is independent of the working time used.
Impregum™ Polyether Impression Material

Linear Dimensional Change of Impression Materials at Different Storage Conditions

J.C. FARR, B. KUPPERMANN, P. OSSWALD, J. ZECH, E. WANEK AND A. VIEHBECK, 3M ESPE, 3M Deutschland GmbH, Seefeld, Germany

Objectives: The linear dimensional change of monophase impression materials after 24 hours and after 14 days was analyzed at three different conditions.

Methods: For this study two polyether monophase impression materials (Impregum™ Penta™ Soft Medium Body Impression Material; IPS; and Impregum™ Penta™ Medium Body Impression Material; IMP), two VPS monophase impression materials (Aquasil Ultra Deca 380 Monophase; AQU; and Take 1 Advanced Medium; TA1) and one hybrid monophase impression material (EXA'ience 370 Medium Body, EXA) were used. Three specimens of each material were prepared according to ISO 4823:2000 and stored up to 14 days at three different storage conditions with varying humidity of 2 ± 1% rH, 50 ± 10% rH and 98 ± 1% rH. The linear dimensional change of each specimen was evaluated twice using two different spots (n=6).

<table>
<thead>
<tr>
<th>Name</th>
<th>Manufacturer</th>
<th>Code</th>
<th>Lot #</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impregum™ Penta™ Soft Polyether Impression Material</td>
<td>3M ESPE</td>
<td>IPS</td>
<td>B#517272; C#516617</td>
</tr>
<tr>
<td>Impregum™ Penta™ Polyether Impression Material</td>
<td>3M ESPE</td>
<td>IMP</td>
<td>B#434951; C#435694</td>
</tr>
<tr>
<td>Aquasil Ultra Deca 380 Monophase</td>
<td>Dentsply Caulk</td>
<td>AQU</td>
<td>#130429</td>
</tr>
<tr>
<td>Take 1 Advanced Medium</td>
<td>Kerr</td>
<td>TA1</td>
<td>#1-1353</td>
</tr>
<tr>
<td>EXA'ience 370 Medium Body</td>
<td>GC</td>
<td>EXA</td>
<td>#1203081</td>
</tr>
</tbody>
</table>

Table 1: Materials used in this study.

Results: Results and standard deviations obtained by one-way-Anova and Tukey Test (p< 0.05) are shown below. Additionally, all materials fulfilled the ISO criterion for gypsum compatibility after 14 days.

<table>
<thead>
<tr>
<th>Materials (n=6)</th>
<th>Linear Dimensional Change [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dry (2% rH) 24 Hours</td>
</tr>
<tr>
<td>IPS</td>
<td>-0.12 (0.14)</td>
</tr>
<tr>
<td>IMP</td>
<td>-0.43 (0.09)</td>
</tr>
<tr>
<td>AQU</td>
<td>-0.33 (0.05)</td>
</tr>
<tr>
<td>EXA</td>
<td>-0.40 (0.12)</td>
</tr>
<tr>
<td>TA1</td>
<td>-0.37 (0.03)</td>
</tr>
</tbody>
</table>

Table 2: Linear Dimensional Change in monophase impression materials. Means that do not share a letter are significantly different.
Impregum™ Polyether Impression Material (cont.)

Figure 1: Linear Dimensional Change in monophase impression materials. Left: 24 hour storage, Right: 14 day storage. Means that do not share a letter are significantly different.

**Conclusions:** Every material fulfilled the requirement of ISO 4823:2000 for the Linear Dimensional Change (max. 1.5%) at 24 hours and even after 14 days at standard conditions (50% rH) and also at extreme dry and wet conditions. Based on this study it can be concluded that delayed pouring of impressions after up to 14 days will not negatively affect the detail accuracy of the received models.

3M ESPE recommends pouring polyether impressions within 14 days after taking the impression.

**3M ESPE Summary**

**Aim of Study:** This study analyzed how adverse storage conditions affect the dimensional stability and gypsum of elastomeric impression materials.

**Summary of Results:** The dimensional changes of all impression materials tested were still well within the ISO 4823:2000 criteria for dimensional change and gypsum compatibility. While Polyether impression materials should only be stored for up to 14 days they were found to be at least as dimensionally stable within this time compared to other elastomeric impression materials. Adverse storage conditions did not have affect dimensional stability to a critical degree.
Impregum™ Polyether Impression Material

Physical Properties Comparison of Four Elastomers Used in Implant Dentistry

VASQUEZ², G. ARDILA², L.F. NEMOCON¹ and J.R. RIVERA², ¹Fundación Centro De Investigación Y Estudios Odontológicos Cieo, Bogota, Colombia, ²Fundación Centro De Investigación Y Estudios Odontológicos Cieo, Bogotá, Colombia

Objectives: To compare the surface detail reproduction and flowability of four different elastomeric impression materials used in implant dentistry.

Methods: One hundred forty-four (144) specimens were tested following the ADA specification 19 and previous information reported at the literature. They were fabricated using two biphasic and monophasic vinyl polysiloxane materials: Parasil and Monopren (Kettenbach, Eschenburg, Germany); one monophasic polyether material: Impregum™ Polyether Impression Material (3M ESPE, Seefeld, Germany) and one monophasic vinylsiloxane ether material: Identium (Kettenbach, Eschenburg, Germany). Specimens were distributed into three groups: 96 impressions for surface detail reproduction (SDR) at dry and moist conditions and 48 shark fins for flowability (FW). For the first property, impressions were made of stainless steel dies with two vertical and three horizontal lines inscribed on the die superior surface in where continuous replication of at least two of the three horizontal lines was determined. Second property was evaluated using the “shark fin test”, in where height of the specimens was measured with a digital caliper (Red Line Mechanics, Chatsworth, CA) after complete setting of the impression materials. Finally, statistical analysis for SDR was performed using Kruskal Wallis and Mann Whitney U tests. FW was evaluated using one way ANOVA and Tukey tests.

Results: Surface detail reproduction showed no statistical significant difference between the four impression materials under dry condition. Moist condition comparison showed a statistical significant difference (p=0.023). Identium displayed the most satisfactory results, followed by Impregum™ Polyether Impression Material and Parasil, while Monopren impressions were the worst. Flowability showed statistical differences (p=0.000). Impregum displayed the highest flowability values, followed by Parasil, Identium and Monopren. No statistical differences were observed between the last two.

Conclusions: Polyether based materials (Impregum™ Polyether Impression Material) or polyether-based combinations (Identium) produced more satisfactory impressions in moist conditions. The consistency of the material determines its flowability in specific clinical situations.

3M ESPE Summary

Aim of Study: The study compared the detail reproduction and flowability of Impregum™ Polyether Impression Material with other elastomeric impression materials with stainless steel dies and shark-fin testing.

Summary of Results: Impregum showed the highest flowability and Impregum and Impregum™ Polyether Impression Material showed the best detail reproduction in moist conditions.
Imprint™ 4 VPS Impression Material

A New Method to Directly Compare Hydrophilicity in Impression Materials

J.C. FARR, P. OSSWALD, R. HAMPE, H. HOFFMANN, J. ZECH

Objectives: A new method to measure and compare the hydrophilicity of impression materials in the unset stage is described here. Four commercial light-bodied vinyl polysiloxane (VPS) materials and two commercial hybrid materials were each compared to one experimental light-bodied VPS on a 2-material side-by-side interface setup. A drop of water placed on this interface will spread and flow towards the more hydrophilic material.

Methods: For this study, Aquasil Ultra XLV regular set (Dentsply Caulk, #120411; AQU), Flexitime Light Flow (Heraeus Kulzer, #350024; FLF), Panasil Initial Contact Light (Kettenbach, #100231, PIC), Take 1 Advanced Light Body regular set (Kerr, #2-1065; T1A), Identi mum Light (Kettenbach, #110071, IDE), Exa’lence light regular set (GC, #1012131, EXL) and one new light-bodied-material (Imprint™ 4 VPS Impression Material, #AWT-0027; EXP) were used as impression materials. A side-by-side interface of two impression materials was prepared. A drop of water (5µl) was placed exactly on the interface of both materials 40s after start of mixing with a commercial DropShape Analysis-System (DSA-30, Kruess) and at a drop age of 2s the horizontal spreading distance of water in mm on both materials was measured. As a control, EXP on both sides was tested (all N=5). The experimental material is now marketed as Imprint™ 4 Light Body Impression Material.

Results: Results and standard deviations are shown below. One-way ANOVA and Tukey Test revealed significant differences between materials with the water drop always flowing more towards EXP. The side-by-side comparison of Imprint 4 did not reveal statistically significant differences and thus shows the validity of this method.

Conclusions: A method with low standard deviations for directly comparing the hydrophilicity of impression materials was established. EXP was found to show the highest affinity to water. This increased hydrophilicity in the unset stage may improve the materials flow properties in moist conditions. The clinical relevance has yet to be tested.

![Figure 1: Top — Setup for measuring drop distribution (horizontal spreading distance) on the interface of two different impression materials (DSA-30, Kruess). Bottom — Image of the drop shape acquired with a high resolution camera from a more upsight angle.](image)

![Figure 2: Mean values of spreading distance (in mm) for different commercial materials vs. Imprint™ 4 VPS Impression Material.](image)
Imprint™ 4 VPS Impression Material (cont.)

3M ESPE Summary

Aim of Study: The aim of this study was to develop and describe a method that directly compares the hydrophilic behavior of unset impression materials and show the superior hydrophilicity of Imprint™ 4 VPS Impression Material in the unset state.

Summary of Results: Imprint™ 4 VPS Impression Material could be shown to be superior with regard to hydrophilicity to all other tested unset impression materials. The new method was found to work reliably with low standard deviation.

<table>
<thead>
<tr>
<th>Materials (n=5)</th>
<th>Commercial Material (in mm)</th>
<th>EXP (in mm)</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXP-Control</td>
<td>2.72 (0.27)</td>
<td>2.43 (0.14)</td>
<td>0.91 (0.14)*a</td>
</tr>
<tr>
<td>AQU</td>
<td>1.01 (0.18)</td>
<td>3.78 (0.09)</td>
<td>3.85 (0.84)c</td>
</tr>
<tr>
<td>FLF</td>
<td>0.85 (0.06)</td>
<td>3.74 (0.1)</td>
<td>4.42 (0.37)c</td>
</tr>
<tr>
<td>PIC</td>
<td>1.44 (0.33)</td>
<td>3.39 (0.27)</td>
<td>2.51 (0.83)b</td>
</tr>
<tr>
<td>T1A</td>
<td>1.05 (0.14)</td>
<td>3.68 (0.05)</td>
<td>3.55 (0.5)bc</td>
</tr>
<tr>
<td>IDE</td>
<td>1.45 (0.28)</td>
<td>3.25 (0.19)</td>
<td>2.32 (0.6)b</td>
</tr>
<tr>
<td>EXL</td>
<td>0.87 (0.13)</td>
<td>3.63 (0.09)</td>
<td>4.25 (0.71)c</td>
</tr>
</tbody>
</table>

Table 1: Means of horizontal spreading distance and ratio of different materials. Means that do not share a letter are significantly different.
* No statistically difference between both sides.
IR Imaging as Temperature Measurement Method for Dental Impression Materials

P. OSSWALD, J. ZECH, H. HOFFMANN, J. FETZ, R. HAMPE, J.C. FARR

Objectives: The self-warming of a vinylpolysiloxane (VPS) tray precision impression materials was studied by IR imaging, a unique measurement method for temperature in dentistry.

Methods: For this study, a new experimental tray material (LOT: B:463580; K:463717, EXP), Express™ 2 Penta™ H Impression Material (LOT: B#495473 K#494229, EX2), Exa’lence 370 Heavy Tray (LOT: 1204051, EXA), Flexitime Heavy Tray (LOT: 380191, FLE), Aquasil Ultra Heavy Deca (LOT: 120829, AQU), Panasil Tray Soft Heavy (LOT: 1204051, EXA), Flexitime Heavy Tray (LOT: 380191, FLE), Aquasil Ultra Heavy Deca (LOT: 120829, AQU), Panasil Tray Soft Heavy (LOT: 1204051, EXA), Flexitime Heavy Tray (LOT: 380191, FLE), were used as impression materials. For IR measurement two plastic trays have been filled simultaneously with EXP and a second tray material at 22°C by using a Pentamix™ 3 Automatic Mixing Unit. The filled trays were placed in front of IR camera FLIR T640 with a 45° lens and the recording of the thermographic videos was started 60 seconds after start of mixing. The temperature measured 2 minutes after start of mixing (T2min) as well as the maximum temperature (Tmax) has been evaluated.

Results: Results and standard deviations obtained by one-way-Anova and Tukey Test (p<0.05) are shown below. Whereas for the T2min no big differences can be observed for the investigated materials, Imprint™ 4 showed the highest maximum temperature of all materials.

<table>
<thead>
<tr>
<th>Impression Material</th>
<th>Abbreviation</th>
<th>T2min [°C]</th>
<th>Tmax [°C]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Imprint™ 4 VPS Heavy (3M ESPE)</td>
<td>EXP</td>
<td>25.7 (0.6)</td>
<td>33.8 (0.5)</td>
</tr>
<tr>
<td>Express™ 2 VPS Impression Material/Imprint™ 3 VPS Impression Material</td>
<td>EX2</td>
<td>25.4 (0.1)</td>
<td>27.2 (0.4)</td>
</tr>
<tr>
<td>Exa’lence 370 Heavy Tray (GC)</td>
<td>EXA</td>
<td>26.7 (0.3)</td>
<td>28.9 (0.3)</td>
</tr>
<tr>
<td>Flexitime Heavy Tray (Heraeus Kulzer)</td>
<td>FLE</td>
<td>24.8 (0.2)</td>
<td>26.5 (0.2)</td>
</tr>
<tr>
<td>Aquasil Ultra Heavy Deca (Dentsply)</td>
<td>AQU</td>
<td>25.9 (0.3)</td>
<td>27.9 (0.7)</td>
</tr>
<tr>
<td>Panasil Soft Tray Heavy (Kettenbach)</td>
<td>PAN</td>
<td>26.5 (0.1)</td>
<td>27.3 (0.1)</td>
</tr>
<tr>
<td>Identium Heavy (Kettenbach)</td>
<td>IDE</td>
<td>25.8 (0.4)</td>
<td>26.2 (0.3)</td>
</tr>
</tbody>
</table>

Conclusions: Results and standard deviations obtained by one-way-Anova and Tukey Test (p<0.05) are shown below. Whereas for the T2min no big differences can be observed for the investigated materials, EXP showed the highest maximum temperature of all materials.

3M ESPE Summary

Aim of Study: This study aimed to establish IR imaging as a method to analyze temperature development in VPS and hybrid impression materials during setting and further showing the difference between Imprint™ 4 VPS Impression Material and all other impression materials.

Summary of Results: Only Imprint™ 4 VPS Impression Material showed a significant temperature increase during setting. Whereas for the T2min no big differences could be observed for the investigated materials, Imprint™ 4 VPS Impression Material showed the highest maximum temperature of all materials. The temperature maximum was reached after the mouth removal of the impression material.
3M ESPE Summary

**Aim of Study:** This study aimed to establish IR imaging as a method to analyze temperature development in VPS and hybrid impression materials during setting and further showing the difference between Imprint™ 4 VPS Impression Material and all other impression materials.

**Summary of Results:** Only Imprint™ 4 VPS Impression Material showed a significant temperature increase during setting. Whereas for the T2min no big differences could be observed for the investigated materials, Imprint™ 4 VPS Impression Material showed the highest maximum temperature of all materials. The temperature maximum was reached after the mouth removal of the impression material.

![Figure 1: Temperature development in impression materials during setting.](image1)

![Figure 2: Representative thermographic images at Tmax for each of the investigated impression materials.](image2)
New Encapsulated Astringent Retraction Paste Evaluated by UK General Practitioners

R.J. CRISP, College of Medical & Dental Sciences, University of Birmingham, Birmingham, England and F.T. BURKE, Dental School, University of Birmingham, Birmingham, England

Objectives: To assess the handling properties of a new encapsulated astringent paste retraction system with a tip that places the material directly into the gingival sulcus.

Methods: Twelve UK general dental practitioner (GDP) members of the practice-based research group, The PREP Panel, received instructions, questionnaires and packs of the Astringent Retraction Paste (3M ESPE, Seefeld, Germany) capsules. The GDPs used the system for eight weeks and returned the questionnaire (designed to evaluate current gingival retraction techniques and rate the presentation, instructions, dispensing and handling properties of the new system). Most responses were on visual analogue scales (VAS).

Results: The majority of the evaluators (58%) placed over 10 indirect restorations in a typical month. The most commonly used method for gingival retraction was single cord (58%). The presentation and instructions achieved a high score of 4.8 (on a VAS where 1 = poor and 5 = excellent). A total 160 impressions were taken, with the new system scoring higher for ease of use than the pre-evaluation retraction system (4.4 v 3.9 on a VAS where 1 = Difficult to use and 5 = easy to use). 75% of the evaluators stated that the new astringent retraction paste had very good haemostatic properties and that the capsule placed the paste well in the gingival sulcus. The paste also scored above average for time saving, producing a dry and clean field for impression taking, patient comfort, hygiene and overall satisfaction. 75% of the evaluators would purchase the system and 83% of evaluators would recommend the astringent retraction paste to colleagues.

Conclusions: The new encapsulated astringent retraction paste system was well received by the evaluators as indicated by the high ratings over a wide range of criteria and the number that would recommend them to colleagues.

3M ESPE Summary

Aim of Study: Evaluation of handling properties of Retraction Capsule/Astringent Retraction Paste in a group of 12 general dental practitioners.

Summary of Results:

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Average score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ease of Use</td>
<td>4.0</td>
</tr>
<tr>
<td>Time Saving</td>
<td>4.0</td>
</tr>
<tr>
<td>Overall Satisfaction</td>
<td>3.9</td>
</tr>
<tr>
<td>Intention to Purchase</td>
<td>Yes = 75%</td>
</tr>
<tr>
<td>Intention to Recommend</td>
<td>Yes = 83%</td>
</tr>
</tbody>
</table>

- 83% (n=10) agreed that Astringent Retraction Paste is a very suitable product for gingival retraction.
- 67% (n=8) agreed that in most cases Astringent Retraction Paste eliminated the need to use cord.
- 75% (n=9) agreed that Astringent Retraction Paste has very good haemostatic properties.
- 100% agreed the capsule is well suited to place the retraction paste in the sulcus.
- 83% (n=10) agreed the use of Astringent Retraction Paste makes the retraction procedure more efficient.
Hydrophilicity and Viscosity: Effect on Gingival-Sulcus Reproduction Using Elastomeric Impression-Materials

M. EL DEEB, N.A. HABIB and G.H. WALY, Biomaterials Department, Faculty of Oral and Dental Medicine Cairo University, Cairo, Egypt

Objectives: This study aimed to evaluate the hydrophilicity and viscosity of two hydrophilic elastomeric impression materials, one addition silicone and one polyether material, in their light and medium consistencies, as well as their ability to accurately reproduce the gingival sulcus within the working time recommended by the manufacturer.

Methods: Evaluation of hydrophilicity was done by the contact angle method. Viscosity was measured using Bohlin rheometer. Finally, impressions were made to compare between the ability of the tested materials to record the gingival sulcus. To simulate the clinical situation, a model was made of a natural tooth with a sub-gingivally placed finishing line, surrounded by agar hydrocolloid material. Impressions were made twice, one minute after mixing and then at the end of the working time. The penetration of the impression material into the sulcus was measured using a stereomicroscope.

Results: Polyether materials (Impregum/3M ESPE) showed statistically significant lower mean contact angle than the addition silicones (Aquasil/Dentsply) (P≤0.05). The light-bodied polyether material had the lowest viscosity, both at the beginning and at the end of working time (P≤0.05). Polyether materials produced statistically significant deeper penetration into the gingival-sulcus than the addition silicones (P≤0.05). Also, the impressions made at the end of working time showed deeper sulcus extension than those made at the beginning of the working time (P≤0.05).

Conclusions: Polyether elastomeric impression materials are still more hydrophilic than the hydrophilized types of addition silicones. Accurate reproduction of the gingival sulcus is affected by both the hydrophilicity of the impression material and its ability to displace the gingival tissues (viscosity). It was possible to produce impressions with acceptable sulcus reproduction even at the end of the working time recommended by the manufacturer, except for medium-bodied polyether which showed premature setting.

3M ESPE Summary

Aim of Study: The study compared the impression material classes VPS and Polyether with regard to hydrophilicity, consistency at different times of working time and sulcus penetration depths in an in vitro model.

Summary of Results: Impregum™ Polyether Impression Material was found to have significantly lower contact angles compared to Aquasil. Impregum™ Polyether Impression Material also had the lowest viscosity, both at the beginning and at the end of working time. It was found to penetrate deeper into the gingival sulcus model. Impressions made at the end of working time showed deeper sulcus extension than those made at the beginning of the working time.
**Impregum™ Penta™ and Penta™ Soft, 3M™ ESPE™ Monophase and Soft Monophase Polyether Impression Material**

Comparison of Linear Dimensional Change of Polyether Impression Materials

J. ZECH, J.C. FARR, B. KUPPERMANN, E. WANNEK, R. GUGGENBERGER AND A. VIEHBECK, 3M ESPE, 3M Deutschland GmbH, Seefeld, Germany

**Objectives:** The linear dimensional change of two commercial and two newly introduced polyether monophase impression materials after 24 hours and 14 days was analyzed at different storage conditions.

**Methods:** For this study two established (Impregum™ Penta™ Soft Medium Body Impression Material; B#517272; C#516617, IPS; and Impregum™ Penta™ Medium Body Impression Material; B#434951; C#435694, IMP) and two newly introduced polyether impression materials (3M™ ESPE™ Soft Monophase; B#496372; C#496013; SMP, 3M™ ESPE™ Monophase, B#496356; C#496013; MP) were used. Two materials with a final shore A hardness in the range of 60 (IMP, MP) and two softer materials with a final shore hardness in the range of 50 (IPS, SMP) were compared with each other. At least three specimen of each material were prepared according to ISO 4823:2000 and stored up to 14 days at three different storage conditions with varying humidity of 2 ± 1% rH, 50 ± 10% rH and 98 ± 1% rH. The linear dimensional change of each specimen was evaluated twice using two different spots (n≥6).

**Results:** Results and standard deviations obtained by one-way-Anova and Tukey-Test (p<0.05) are shown below. Additionally, all materials fulfilled the ISO criterion for gypsum compatibility after 14 days.

<table>
<thead>
<tr>
<th>Material</th>
<th>Code</th>
<th>Linear Dimensional Change [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>24 Hours</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impregum™ Penta™ Impression Material</td>
<td>IMP</td>
<td>-0.43 (0.09)&lt;c&gt;</td>
</tr>
<tr>
<td>3M™ ESPE™ Monophase</td>
<td>MP</td>
<td>-0.45 (0.02)&lt;c&gt;</td>
</tr>
<tr>
<td>Impregum™ Penta™ Soft</td>
<td>IPS</td>
<td>-0.17 (0.09)&lt;a&gt;</td>
</tr>
<tr>
<td>3M™ ESPE™ Soft Monophase</td>
<td>SMP</td>
<td>-0.31 (0.07)&lt;b&gt;</td>
</tr>
<tr>
<td><strong>14 Days</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impregum™ Penta™ Impression Material</td>
<td>IMP</td>
<td>-0.56 (0.12)&lt;a,c&gt;</td>
</tr>
<tr>
<td>3M™ ESPE™ Monophase</td>
<td>MP</td>
<td>-0.64 (0.05)&lt;c&gt;</td>
</tr>
<tr>
<td>Impregum™ Penta™ Soft</td>
<td>IPS</td>
<td>-0.39 (0.04)&lt;a&gt;</td>
</tr>
<tr>
<td>3M™ ESPE™ Soft Monophase</td>
<td>SMP</td>
<td>-0.47 (0.06)&lt;a,b&gt;</td>
</tr>
</tbody>
</table>

Table 1: Linear dimensional change of polyether impression materials at different storage conditions and durations. Means that do not share a letter are significantly different.

![Figure 1: Linear Dimensional change of polyether impression materials at different storage conditions and durations.](continued on next page)
Impregum™ Penta™ and Penta™ Soft, 3M™ ESPE™ Monophase and Soft Monophase Polyether Impression Material

Conclusions: All materials fulfilled the requirement of ISO4823:2000 for Linear Dimensional Change (maximum 1.5%) after 24 hours and 14 days even under extreme conditions. There was no statistically significant difference between the corresponding IMP/MP and IPS/SMP at 24 hours/standard conditions. It can be concluded that delayed pouring of polyether impressions after ≤14 days will not negatively affect the quality of the received models. 3M ESPE recommends pouring polyether impressions within 14 days after taking the impression.

3M ESPE Summary

Aim of Study: Aim of the study was to test the dimensional stability of polyethers at different storage conditions and to compare Impregum™ Penta and Impregum™ Penta™ Soft as polyethers with a long market history with Monophase and Soft Monophase as two newly introduced polyethers.

Summary of Results: All materials maintained their dimension for the maximum recommended storage time even at adverse storage conditions. Also, Impregum and Monophase materials were found to behave highly similary.
Long Term Dimensional Stability of Alginate Replacement VPS Materials

J.C. FARR, P. OSSWALD, J. ZECH, E. WANEK, R. GUGGENBERGER and A. VIEHBECK, 3M ESPE, 3M Deutschland GmbH, Seefeld, Germany

Objectives: To analyze the dimensional stability of alginate replacement VPS impression materials after long term storage.

Methods: For this study one commercial (Silginat, #120401-135, Heraeus Kulzer) and one newly introduced (Imprint™ 4 Preliminary VPS Impression Material, B:0053, C:0028, 3M ESPE) alginate replacement materials in 5:1 automix delivery were analyzed for their linear dimensional change according to ISO 4823:2000. Samples were analyzed after 1 hour, 14 days and 84 days. Thirty (30) minutes after setting the materials were also tested for their gypsum compatibility in multiple pours by performing the gypsum compatibility test according to ISO4823:2000 for five subsequent times.

Results: Results and standard deviations obtained by one-way-Anova and Tukey Test (p<0.05) are shown below. Additionally, both materials fulfilled the gypsum compatibility test according to ISO 4823:2000 if poured five subsequent times.

<table>
<thead>
<tr>
<th>Material</th>
<th>1 Hour</th>
<th>14 Days</th>
<th>84 Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silginat</td>
<td>0.17 (0.05)(^a)</td>
<td>0.21 (0.02)(^a)</td>
<td>0.33 (0.01)(^b)</td>
</tr>
<tr>
<td>Imprint™ 4 Preliminary Penta™</td>
<td>0.18 (0.03)(^a)</td>
<td>0.20 (0.01)(^a)</td>
<td>0.18 (0.03)(^a)</td>
</tr>
</tbody>
</table>

Table 1: Linear Dimensional Change of Alginate replacement VPS impression materials at different times of storage. Means that do not share a later are significantly different (N05).

Conclusions: Both materials fulfill the ISO 4823:2000 criteria for linear dimensional change of a maximum of 1.5% change even after 12 weeks of storage. Also, both materials were found to be capable of being poured multiple times as they maintained their gypsum compatibility according to ISO 4823:2000 even after five consecutive pours. While no statistically significant differences between materials were found at one hour and 14 days Silginat shows a stronger change of dimensions after 84 days. Imprint™ 4 Preliminary Penta™ Impression Material showed no change within 12 weeks so it can be assumed that the material will remain stable for an even longer time than tested here. Long term dimensional stability of impression materials allows for storage of the impression, e.g. for multiple pours or to prepare several temporaries in case of long term temporization cases.

3M ESPE Summary

Aim of Study: To find out how the storage of VPS alginate impression materials for a above average duration affects the dimensional stability.

Summary of Results: Imprint™ 4 Preliminary Penta™ Impression Material was found remain unchanged over a period of 12 weeks storage. Silginat showed only minimal changes at 12 weeks. Long term dimensional stability of impression materials can be very important e.g. for long term temporization cases where it is important to be able to remake a temporary.
**Objectives:** To compare the extrusion forces of eight commercially available heavy body materials with two newly introduced VPS impression materials in 50mL cartridge delivery. Low extrusion forces will result in less hand-fatigue and potentially faster extrusion speed.

**Methods:** For this study, the extrusion forces at 75mm/minute (FEX75) and at 150mm/minute (FEX150) extrusion speed were measured six times for the fast set heavy body materials Imprint™ 4 Super Quick Heavy Impression Material (IM4SQ,#505465) (3M ESPE), Take 1 Advanced Tray Superfast Set (T1SF,#3-2128) (Kerr), Aquasil Ultra Heavy Superfast Set (AQSF,#120913) (Dentsply), Exa’lence Heavy Body Fast Set (EXF, #1202171) (GC) and Flexitime Xtreme Heavy Tray (FLF,#340379) (Heraeus Kulzer), as well as for the regular set materials Imprint™ 4 Heavy Body Impression Material (IM4R,#505464), Take 1 Advanced Tray Regular Set (T1R,#2-2129), Aquasil Ultra Heavy Regular Set (AQR,#121023), Exa’lence Heavy Body (EXH, #1208281) and Flexitime Heavy Tray (FLR, #380267). The obtained values were evaluated independently for the fast set as well as for the regular set materials at each extrusion speed. The difference in extrusion forces $F_{EX} = F_{EX150} - F_{EX75}$ was calculated.

**Results:** Results and standard deviations are shown below. One-way ANOVA and Tukey Test revealed significant differences. IM4SQ as well as IM4R showed the lowest extrusion forces in the respective setting regime and at both extrusion speeds as well as the lowest $F_{EX}$ values.

<table>
<thead>
<tr>
<th>Material</th>
<th>Code</th>
<th>$F_{EX75}$ [N]</th>
<th>$F_{EX150}$ [N]</th>
<th>$F_{EX}$ [N]</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fast Set</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Imprint™ 4 Super Quick Heavy</td>
<td>IM4SQ</td>
<td>347.9 ± 4.4$^a$</td>
<td>486.0 ± 3.8$^a$</td>
<td>138.3 ± 5.4</td>
</tr>
<tr>
<td>Take 1 Advanced Tray Super Fast</td>
<td>T1SF</td>
<td>637.5 ± 5.9$^b$</td>
<td>928.9 ± 12.0$^b$</td>
<td>291.5 ± 12.2</td>
</tr>
<tr>
<td>Aquasil Ultra Heavy Superfast Set</td>
<td>AQSF</td>
<td>657.6 ± 8.5$^c$</td>
<td>1006.5 ± 3.7$^c$</td>
<td>348.9 ± 9.3</td>
</tr>
<tr>
<td>Exa’lence Heavy Body Fast Set</td>
<td>EXF</td>
<td>489.2 ± 5.4$^d$</td>
<td>750.9 ± 10.1$^d$</td>
<td>261.8 ± 11.1</td>
</tr>
<tr>
<td>Flexitime Xtreme Heavy Tray</td>
<td>FLF</td>
<td>549.2 ± 6.1$^e$</td>
<td>859.4 ± 12.0$^e$</td>
<td>310.2 ± 13.0</td>
</tr>
<tr>
<td><strong>Regular Set</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Imprint™ 4 Heavy</td>
<td>IM4R</td>
<td>322.5 ± 3.9$^a$</td>
<td>457.3 ± 5.8$^a$</td>
<td>134.8 ± 6.6</td>
</tr>
<tr>
<td>Take 1 Advanced Tray Regular Set</td>
<td>T1R</td>
<td>566.6 ± 3.5$^c$</td>
<td>846.0 ± 6.2$^c$</td>
<td>279.4 ± 6.7</td>
</tr>
<tr>
<td>Aquasil Ultra Heavy Regular Set</td>
<td>AQR</td>
<td>589.8 ± 2.9$^c$</td>
<td>914.7 ± 4.3$^c$</td>
<td>324.9 ± 4.9</td>
</tr>
<tr>
<td>Exa’lence Heavy Body</td>
<td>EXR</td>
<td>509.9 ± 10.0$^b$</td>
<td>778.5 ± 9.0$^b$</td>
<td>268.6 ± 12.4</td>
</tr>
<tr>
<td>Flexitime Heavy Tray</td>
<td>FLR</td>
<td>503.6 ± 3.5$^a$</td>
<td>797.6 ± 0.8$^a$</td>
<td>294.0 ± 3.8</td>
</tr>
</tbody>
</table>

Table 1: Extrusion forces of heavy body materials at 75mm/minute and 150mm/minute and difference between both extrusion speeds. Means that do not share a letter are significantly different.
Conclusions: IM4R and IM4SQ showed the lowest extrusion force compared to materials of the same setting regime facilitating an easier and more convenient application of these materials.

3M ESPE Summary

Aim of Study: The difference of forces required to extrude different cartridge delivery heavy body materials was measured for regular and fast setting impression materials.

Summary of Results: Imprint™ 4 Super Quick Heavy Body Impression Material and Imprint™ 4 Heavy Body Impression Material showed the lowest extrusion force at both extrusion speed. Low extrusion force will help to reduce hand fatigue from dispensing and allow for faster dispensing which is of special importance for fast setting impression materials.
Imprint™ 4 VPS Impression Material, Imprint™ 3 VPS Impression Material

Comparison of New Self-Warming VPS Impression Material to Gold-Standard VPS

S. DOGAN, E.R. SCHWEDHELM, L. MANCL and H. HEINDL, University Of Washington, Seattle, WA, Aesthetic Dental Creation, Mill Creek, WA

Objectives: The primary aim of this study was to compare a new self-warming fast-setting vinyl polysiloxane (VPS) impression material with heavy body/light body (HB/LB) combination (Imprint™ 4 VPS Impression Material, 3M ESPE) (experimental group) versus a gold-standard VPS impression material with HB/LB combination (Imprint™ 3 VPS Impression Material, 3M ESPE) (control group) using one-step impression technique.

Methods: Total of 40 impressions, two impressions of each 20 single crowns from 20 patients (mean: 56.7, SD:11.8 yo), were made. The order of impression making was randomized. Impressions were rated by clinical operators using an ordinal rating scale (alpha = excellent, no defects; bravo = acceptable, small defects; charlie = other defects require impression to be remade; delta = unacceptable, defects at finish-line). Impressions and poured stone casts were rated for the handling properties and for the selection of master cast by the dental technician. Stone casts were sent to clinical operators, blinded to the material, for their master cast selection. In case of a difference between the technician’s and operator’s selection, consensus evaluation was made for the final selection. McNemar’s test for paired proportions and the Sign test were used for the statistical comparisons.

Results: Thirteen (65%; 95% CI, 44 to 86%) of the experimental and 17 (85%; 95% CI, 69 to 100%) of the control impression preparation areas were rated as “alpha” or “bravo” by the evaluators (p=0.16). Although the difference in the percentage of “alpha” or “bravo” ratings was not statistically significant, the 95% confidence interval (-6% to 46%) favored the control group. Eleven dies from the control and nine from the experimental group were selected for the fabrication of the definitive crowns (p=0.65).

Conclusions: Within the limitations of this clinical study there was no statistical difference in the performance of the experimental and the control groups. Impressions made with both materials were clinically acceptable.

3M ESPE Summary

Aim of Study: This study analyzed the clinical performance of Imprint™ 4 VPS Impression Material and Imprint™ 3 VPS VPS Impression Material in the one-step technique.

Summary of Results: While the clinical performance of both products was not statistically different patients preferred Imprint™ 4 VPS Impression Material over Imprint™ 3 VPS Impression Material (Source: Internal report to 3M ESPE).
Impression Material References

AADR

AADR 2014 Abstract #281
Simulated Sulcular Performance of Current Commercial Elastomers
A. BOGHOSIAN, Northwestern University, Chicago, IL, L.T. LE, Sherman Dental Associates, Evanston, IL and P. MONAGHAN, Sherman Dental Associates of Evanston, Evanston, IL

AADR 2014 Abstract #282
Tear Strength of Eight Commercially Available Elastomeric Impression Materials
K. SAWLANI, S. JANYAVULA, L.C. RAMP and J. BURGESS, School of Dentistry, University of Alabama at Birmingham, Birmingham, AL, and Dentsply Caulk, Milford, DE

AADR 2014 Abstract #283
Polyvinyl-Siloxane Impression Materials Performance in a Tensile Strength Test
J.G. SMALL, E. CICIOLLA, R.D. PERRY and M. HARSONO, Tufts University School of Dental Medicine, Boston, MA

AADR 2014 Abstract #284
Physical Properties Of VPS Impression Materials
S. SINGHAL, G. TYSOWSKY and S.A. ANTONSON, Ivoclar Vivadent, Inc, Amherst, NY, and SUNY at Buffalo, NY, Buffalo, NY

AADR 2014 Abstract #321
Gap Size of Restorations from Direct Digital vs. Cast Scans
A.A.I. BENSALAH, R. GIORDANO II and R. POBER, Boston University, Boston, MA

AADR 2014 Abstract #501
Comparing Immediate Tear Strength of Elastomeric Impression Materials
E. CICIOLLA, J.G. SMALL, M. HARSONO and R. PERRY, Tufts University School of Dental Medicine, Boston, MA

AADR 2014 Abstract #716
Influence of Elastomer Thickness on Tear Strength
L.T. LE, Sherman Dental Associates, Evanston, IL, and A. BOGHOSIAN, Northwestern University, Chicago, IL and P. MONAGHAN, Sherman Dental Associates of Evanston, Evanston, IL

AADR 2014 Abstract #717
Tear Strength of Impression Materials after Recommended Mouth Removal Time
S. JANYAVULA, M. DEBERGALIS, R. BURDE, R. BENNETT, J. GOODCHILD and N. CONTE JR., Dentsply-Caulk, Milford, DE

AADR 2014 Abstract #1170
Sulcus Reproduction of Different Impression Materials in a Semiclinical Model
T. NIEM, U. HEUN, N. KARBE-VOIGT and B. WÖSTMANN, Justus-Liebig-University, Giessen, Germany, and Zentrum für ZMK-Heilkunde — Zahnärztliche Prothetik, Justus-Liebig-University, Giessen, Germany, Justus-Liebig-University Giessen, Giessen, Germany

CED

IADR 2013 CED Abstract #342
Cast Impression of Sterilized Impressions, Long Term Evaluation
Protemp™ 4/Plus Temporization Material

Long-Term Stability of Bisacrylic-Composite Crowns Fabricated Chairside After 24-Months

C.E. SABROSA, B.T. SARTORI, S.G. OLIVEIRA and R.H. MARCHIORI, University of the State of Rio de Janeiro, Rio de Janeiro, Brazil

Objectives: The objective of this clinical trial was to assess long-term stability of complete crowns fabricated chairside from bisacrylic-composite resin materials after 24 months in service.

Methods: Five patients in need of two single crowns were selected. After approval of the ethics committee and informed consent, diagnostic casts were fabricated and diagnostic waxing was prepared for the selected teeth. After caries removal, the selected teeth were built-up with a low-shrink composite resin (Filtek™ Silorane Restorative, 3M ESPE). Teeth that were endodontically treated received a fiber post (RelyX™ Fiber Post, 3M ESPE) cemented with a self-adhesive resin cement (RelyX™ Unicem Clicker™ Cement, 3M ESPE) followed by core reconstruction. Both teeth for each patient were prepared for complete crowns and immediate complete crowns were fabricated with two bisacrylic-composite resin materials (1) Protemp™ 4 Temporization Material (3M ESPE) and (2) Luxatemp Fluorescence (DMG). Crowns were cemented with self-adhesive cement (RelyX™ Unicem Clicker™ Cement). Recalls were made at 1, 3, 6, 12, 18 and 24 months. Marginal fit was evaluated with bite-wing radiographs. Gingival health was evaluated with probing and bleeding indexes. Material properties were evaluated clinically and with photographic documentation. Finally, overall clinical handling and patient satisfaction were documented at each recall.

Results: There were no recorded failures after 24 months. Wear, loss of anatomy and loss of luster was observed in all Luxatemp crowns. Teeth restored with Protemp™ 4 Temporization Material presented with better gingival health. Overall patient satisfaction was very high.

Conclusions: Within the limitations of this study, it can be concluded that after 24 months the direct technique can be viable when using bisacrylic-composite resin materials. Protemp™ 4 Temporization Material performed better with regard to wear, maintenance of surface luster as well as maintenance of gingival health (this study was partially supported by 3M ESPE, Seefeld, Germany).

3M ESPE Summary

Aim of Study: The objective of this clinical trial was to assess long-term stability of complete crowns fabricated chairside from bisacrylic-composite resin materials after 24 months in service.

Summary of Results: Within the limitations of this study, it can be concluded that after 24 months the direct technique can be viable when using bisacrylic-composite resin materials. Protemp™ 4 Temporization Material performed better with regard to wear, maintenance of surface luster as well as maintenance of gingival health.
Protemp™ 4/Plus Temporization Material

Fracture Work, Flexural Strength and Deflection in Provisional Bisacryl Materials

K. SCHWARZ, S. HADER, B. HOFMANN and R. HECHT, 3M Deutschland GmbH, Seefeld, Germany

Objectives: The requirements for provisional restorations with respect to mechanical properties and longevity are increasing, e.g. to enable long-term provisional crowns and bridges. Fracture work as a measure of toughness describes the energy that a material can absorb until failure. A high fracture work is obtained if a material exhibits both high flexural strength and high deflection. In this study fracture work, flexural strength and deflection were studied in four different temporary crown and bridge materials.

Methods: Four provisional materials were tested in a three-point flexural test comparable to ISO4049 to determine fracture work, flexural strength and deflection (N=6) using a Zwick universal testing machine. The materials used were Protemp™ Plus Temporization Material (3M ESPE), Structur 3 (Voco), Luxatemp Star (DMG) and Visalys Temp (Kettenbach). Data were analyzed using a one way ANOVA with a Fisher test and a confidence interval of 95%. Summary of results and mean values including standard deviations (in brackets) were calculated. Values in one row marked with the same superscript characters are not statistically different.

Results: Protemp™ Plus Temporization Material showed significantly higher fracture work and deflection than the other materials tested. Visalys Temp had the highest flexural strength (p>0.05).

<table>
<thead>
<tr>
<th>Material</th>
<th>Protemp™ Plus Temporization Material</th>
<th>Structur 3</th>
<th>Luxatemp Star</th>
<th>Visalys Temp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fracture Work (KJ/m²)</td>
<td>16.2 (±2.9)A</td>
<td>10.7 (±2.5)B</td>
<td>9.5 (±2.1)B</td>
<td>10.8 (±1.7)B</td>
</tr>
<tr>
<td>Flexural Strength (MPa)</td>
<td>103.9 (±3.2)C</td>
<td>107.6 (±7.4)B, C</td>
<td>111.2 (±5.7)B</td>
<td>127.5 (±6.3)A</td>
</tr>
<tr>
<td>Deflection (mm)</td>
<td>1.76 (±0.22)A</td>
<td>1.25 (±0.17)B</td>
<td>1.08 (±0.14)B</td>
<td>1.08 (±0.09)B</td>
</tr>
</tbody>
</table>

Conclusions: The data indicate that Protemp™ Plus Temporization Material has the highest toughness of all materials tested based on a combination of high flexural strength and high deflection. High toughness is a prerequisite for long-term mechanical stability which is especially relevant in indications such as long-term provisional crowns and bridges.

3M ESPE Summary

Aim of Study: The requirements for provisional restorations with respect to mechanical properties and longevity are increasing, e.g. to enable long-term provisional crowns and bridges. Fracture work as a measure of toughness describes the energy that a material can absorb until failure. A high fracture work is obtained if a material exhibits both high flexural strength and high deflection. In this study fracture work, flexural strength and deflection were studied in four different temporary crown and bridge materials.

Summary of Results: The data indicate that Protemp™ Plus Temporization Material has the highest toughness of all materials tested based on a combination of high flexural strength and high deflection. High toughness is a prerequisite for long-term mechanical stability which is especially relevant in indications such as long-term provisional crowns and bridges.
Protemp™ 4/Plus Temporization Material

Flexural Loading Strength of Provisional Restorative Material

L. KOVARY, I. AHLUWALIA, S. JOHN, R.K. GHAFFARI, M. HARSONO and R.D. PERRY, Tufts University School of Dental Medicine, Boston, MA

Objectives: To compare in vitro four commercial provisional restorative materials under flexural loading conditions.

Methods: Sixty provisional bridges were made (n=15 each group) using: Group 1-Protemp™ Plus Temporization Material (3M ESPE), Group 2-Luxatemp® Solar (DMG), Group 3-Integrity® (Dentsply Caulk), Group 4-Visalys® Temp (Kettenbach). Teeth #19 and #21 were prepared as abutments for the three-unit bridge on Typodont (Columbia, NY). Approximate reduction amount was 2–2.5mm on buccal, lingual and proximal walls, 1–1.5mm full deep chamfer margin and 15–20 degrees total occlusal convergence. A metal cast duplicate was made from the Typodont as a template for provisional bridge restorations. Polyvinyl-siloxane impression material was used as a template for fabricating the provisional bridge. The pontic design for missing tooth #20 was a modified ridge lap. All samples were polished with pumice and cemented using TempBond® (Kerr) on a metal template prior to testing. The modified three-point bending test was carried out using a universal testing machine (Instron 5566A, crosshead speed 1.0mm/minute). The initial crack was recorded and testing stopped when it hit a catastrophic failure of the bridge. Data was recorded in Newtons. Statistical analysis was conducted using a one-way analysis of variance (ANOVA) with post hoc Tukey HSD Test for pairwise comparison. Statistical difference was predetermined at p<0.05.

Results: Groups 2 and 3 were statistically lower than Groups 1 and 4. There was no statistical difference between Group 2 and 3 (p=1), nor between Group 1 and 4 (p=0.11).

<table>
<thead>
<tr>
<th>Group (n=15)</th>
<th>Mean Flexural Loading Strength (N)</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>573.94</td>
<td>198.11</td>
</tr>
<tr>
<td>2</td>
<td>296.22</td>
<td>92.13</td>
</tr>
<tr>
<td>3</td>
<td>307.38</td>
<td>106.79</td>
</tr>
<tr>
<td>4</td>
<td>458.35</td>
<td>132.71</td>
</tr>
</tbody>
</table>

Conclusions: Strength testing resulted in Group 1 being comparable to Group 4. Both groups 1 and 4 were significantly higher than Groups 2 and 3. Initial mode of failure was observed on the junctions between abutment crowns and pontics. Fracture resistance in provisional bridges may have clinical implications in the success of final restorations.

3M ESPE Summary

Aim of Study: To compare in vitro four commercial provisional restorative materials under flexural loading conditions.

Summary of Results: Strength testing resulted in Group 1 being comparable to Group 4. Both Groups 1 and 4 were significantly higher than Groups 2 and 3. Initial mode of failure was observed on the junctions between abutment crowns and pontics. Fracture resistance in provisional bridges may have clinical implications in the success of final restorations.

Reprinted with permission from the Journal of Dental Research, J Dent Res 93 (Spec Iss A): 300
https://jdr.oxforduniversitypress.org/content/93/SpecIssA/300/article-pdf/1/43/43.pdf
Comparative In Vitro Evaluation of CAD/CAM vs. Conventional Temporary Crowns

A.O. ABDULLAH, S. POLLINGTON and E. TSITROU, Academic Unit of Restorative Dentistry, University of Sheffield, Sheffield, England

Objectives: The purpose of this study was to compare the marginal and internal fit, fracture strength and mode of fracture of CAD/CAM fabricated temporary crowns to directly made temporary crowns.

Methods: An upper right first premolar phantom tooth was prepared for full ceramic crown. AlphaDie™ MF material was used to duplicate the master model. Four groups were formed with 10 specimen in each group. The materials tested were: VITA CAD-Temp® (KaVo), Polyetheretherketone “PEEK”, Telio CAD-Temp (Ivoclar) and Protemp™ 4 Temporization Material (3M ESPE). For the fabrication of the CAD/CAM crowns the CEREC system V. 3.60 was used for scanning, designing and milling processes. Each crown was tested for fit, fracture strength and mode of fracture. The statistical package SPSS V.18 was used to analyze the data.

Results: The average marginal gap and SD for each group was: VITA CAD-Temp 60.61µm (±9.99), PEEK 46.75µm (±8.26), Telio CAD-Temp 56.10µm (±5.65) and Protemp™ 4 Temporization Material 193.07µm (±35.96). The results showed a statistically significant difference between the groups (P-value <0.01). The average internal fit for each group was: VITA CAD-Temp® 124.94µm (±22.96), PEEK 113.14µm (±23.55), Telio CAD-Temp 110.95µm (±11.64) and Protemp™ 4 Temporization Material 143.48µm (±26.74). The results showed a statistically significant difference. The average fracture strength of each group was: VITA CAD-Temp® 361.01N (±21.61), PEEK 802.23 N (±111.29), Telio CAD-Temp 719.24 N (±95.17) and Protemp™ 4 Temporization Material 416.40 N (±69.14). The results showed a statistically significant difference. The mode of fracture showed non-significant statistical difference (P-value>0.05).

Conclusions: The CEREC CAD/CAM fabricated temporary crowns demonstrated superior fit and better strength than the direct temporary crowns.

3M ESPE Summary

Aim of Study: To compare in vitro four commercial provisional restorative materials under flexural loading conditions.

Summary of Results: The CEREC CAD/CAM fabricated temporary crowns demonstrated superior fit and better strength than the direct temporary crowns.
Protemp™ 4/Plus Temporization Material

Long-Term Stability of Bisacrylic-Composite Crowns Fabricated Chairside After 36-Months

C.E. SABROSA, B.T. SARTORI, P. ANDRADE, L. SALINA, L. POSSIDONIO and K.C. MACHADO, University of the State of Rio de Janeiro, Rio de Janeiro, Brazil

Objectives: The objective of this clinical trial was to assess long-term stability of complete crowns fabricated chairside from bisacrylic composite resin materials after 36 months.

Methods: Five patients in need of two single crowns were selected. After approval of the ethics committee, diagnostic waxing was prepared for the selected teeth. After caries removal, teeth were built-up with a low-shrink composite resin (Filtek™ Silorane Restorative, 3M ESPE). Endodontically treated teeth received a fiber post (RelyX™ Fiber Post, 3M ESPE) cemented with a self-adhesive resin cement (RelyX™ Unicem Clicker™ Cement, 3M ESPE) followed by core reconstruction. All teeth were prepared for complete crowns and immediate complete crowns were fabricated with two bisacrylic composite resin materials (1) Protemp™ 4 Temporization Material (3M ESPE) and (2) Luxatemp Fluorescence (DMG). Crowns were cemented with self-adhesive cement (RelyX™ Unicem Clicker™ Cement). Recalls were made at 1, 3, 6, 12, 18, 24, 30 and 36 months. Marginal fit was evaluated with bite-wing radiographs. Gingival health was evaluated with probing and bleeding indexes. Material properties were evaluated clinically and photographically. Finally, overall clinical handling and patient satisfaction were documented at each recall.

Results: At the 30 month recall, two crowns failed. One patient bit a popcorn and fractured a Protemp™ Crown. Another patient reported with a fractured Luxatemp crown after eating bread. Wear, loss of anatomy and luster was observed in all remaining Luxatemp crowns. Teeth restored with Protemp™ 4 Temporization Material presented better gingival health. Overall patient satisfaction was very high.

Conclusions: Within the limitations of this study, it can be concluded that after 36 months the direct technique can be viable when using bisacrylic composites. One crown of each material fractured. Protemp™ 4 Temporization Material performed better with regard to wear, maintenance of surface luster as well as maintenance of gingival health (this study was partially supported by 3M ESPE, Seefeld, Germany).

3M ESPE Summary

Aim of Study: The objective of this clinical trial was to assess long-term stability of complete crowns fabricated chairside from bisacrylic composite resin materials after 36 months.

Summary of Results: Within the limitations of this study, it can be concluded that after 36 months the direct technique can be viable when using bisacrylic composites. One crown of each material fractured. Protemp™ 4 Temporization Material performed better with regard to wear, maintenance of surface luster as well as maintenance of gingival health.
Protemp™ 4/Plus Temporization Material

Fracture Resistance and Marginal Adaptation of Different Composite Crown Materials

R. LANG, T. BARTSCH and S. HAHNEL, Regensburg University Medical Center, Regensburg, Germany

Objectives: The aim of the study was to investigate the marginal adaptation and fracture resistance of different composite molar crowns for long-term interim prosthetics, luted with RelyX™ Unicem Cement.

Methods: Single molar crowns were fabricated with Protemp™ Crown Temporization Material (3M ESPE), Protemp™ 4 Temporization Material (3M ESPE), Luxatemp® Fluorescence (DMG) and Eclipse® radica™ (Dentsply). Crowns were luted on human molars with RelyX™ Unicem Cement. The roots of the teeth were fixed with a 1mm polyether layer to imitate the periodontium. All crowns were thermocycled and mechanically loaded (TMCL: 6000 x 5°C/55°C, 1.2 x 106 x 50N, 1.66 Hz) with human molar antagonists, then axially loaded to failure (Zwick 1446; v=1mm/minute). Failure detection was set to 10% of Fmax. Marginal adaptation (% perfect margin) was determined by scanning electron microscopy (Phillips Quanta FEG 400, NL, magnification up to 800x) The marginal adaptation was evaluated at the interface between tooth and cement. Statistics: Mann-Whitney U-Test (α=0.05).

Results: The highest fracture resistance and marginal adaptation after TCML were found for Protemp™ Crown Temporization Material (3M ESPE) and Eclipse® radica™ (Dentsply).

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Before TCML</td>
<td>After TCML</td>
<td>Before TCML</td>
<td>After TCML</td>
<td>After TCML</td>
<td></td>
</tr>
<tr>
<td>Protemp™ Crown (3M ESPE)</td>
<td>96.1 (92.0/97.4)</td>
<td>77.9 (67.0/85.0)</td>
<td>97.1 (94.2/98.1)</td>
<td>84.0 (79.1/88.9)</td>
<td>2139</td>
</tr>
<tr>
<td>Protemp™ 4 (3M ESPE)</td>
<td>83.5 (77.0/86.2)</td>
<td>78.0 (70.9/82.8)</td>
<td>87.4 (81.0/91.9)</td>
<td>83.0 (78.5/85.3)</td>
<td>1254</td>
</tr>
<tr>
<td>Luxatemp® Fluorescence (DMG)</td>
<td>87.6 (74.9/93.2)</td>
<td>80.3 (68.1/84.7)</td>
<td>82.8 (74.7/91.0)</td>
<td>74.1 (68.0/85.0)</td>
<td>1102</td>
</tr>
<tr>
<td>Eclipse® radica™ (Dentsply)</td>
<td>89.5 (83.5/91.1)</td>
<td>80.7 (77.5/83.6)</td>
<td>93.5 (90.7/94.9)</td>
<td>85.7 (80.4/90.0)</td>
<td>2384</td>
</tr>
</tbody>
</table>

Conclusions: Within the limits of this in vitro study, the results indicate that Protemp™ Crown Temporization Material (3M ESPE) and Eclipse® radica™ (Dentsply) may be fit for clinical application as long-term interim prosthetics. Clinical research is needed to confirm

3M ESPE Summary

Aim of Study: The aim of the study was to investigate the marginal adaptation and fracture resistance of different composite molar crowns for long-term interim prosthetics, luted with RelyX™ Unicem Cement.

Summary of Results: The highest fracture resistance and marginal adaptation after TCML were found for Protemp™ Crown Temporization Material (3M ESPE) and Eclipse® radica™ (Dentsply).
Dentin Bond Strength of Fiber Posts Cemented with Resin Cements

R.R. PACHECO¹, R.V. RODRIGUES¹, G.M.B. AAMBROSANO², F.M. PASCON¹ and M. GIANNINI¹, ¹State University of Campinas - Piracicaba Dental School, Piracicaba, Brazil, ²Piracicaba Dental School, State University of Campinas-UNICAMP, Piracicaba, SP, Brazil, ³State University of Campinas, Piracicaba, Brazil

Objectives: The aim of this study was to evaluate the push-out bond strength (PBS) to root dentin of composite relined fiber glass posts cemented into the roots of extracted bovine teeth using different adhesive cementation protocols.

Methods: Eighteen roots of bovine teeth were used (n=6). Crowns were removed and roots were embedded in polystyrene resin blocks and sectioned, leaving the root portion with 20mm. Dental root canals were prepared using burs system provided by fiber post manufacturer (WhitePost, FGM), allowing a uniform post space. Posts were silanated (Prosil, FGM) and the root canal was lubricated with a water-soluble glycerin gel to allow the fiber posts relined with composite resin (Z100™ Restorative, 3M ESPE). Three adhesive cementation protocols were evaluated: etch-and-rinse adhesive system (Adper™ Scotchbond™ Multi Purpose Adhesive, 3M ESPE) followed by RelyX™ ARC Adhesive Resin Cement (3M ESPE) (SBMP+ARC); self-adhesive resin cement (RelyX™ Unicem 2 Self-Adhesive Resin Cement, 3M ESPE) (RU2) and multi-mode adhesive (Scotchbond™ Universal Adhesive, 3M ESPE) followed by resin cement (RelyX™ Ultimate Adhesive Resin Cement, 3M ESPE) (SBU+ULT). Roots were sectioned and evaluated at four depths (cervical to apical), by push-out test, which was performed in a universal testing machine (Instron 4411) until bond failure (0.5mm/minute). Data were analyzed using a two-way split-plot ANOVA and Tukey test (p≤0.05).

Results: Means (SD) of PBS according to the group and depth (I=cervical;II=cervical/medium;III-medium/apical;IV-apical).

<table>
<thead>
<tr>
<th>Group</th>
<th>SBMP+ARC</th>
<th>RU2</th>
<th>SBU+ULT</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>5.8 (1.8)Aa</td>
<td>7.8 (1.8)Aa</td>
<td>6.5 (3.4)Aa</td>
</tr>
<tr>
<td>II</td>
<td>4.1 (2.2)Aab</td>
<td>6.23 (1.7)Aab</td>
<td>7.1 (2.7)Aab</td>
</tr>
<tr>
<td>III</td>
<td>3.9 (2.5)Abc</td>
<td>5.1 (1.2)Abc</td>
<td>5.7 (3.3)Abc</td>
</tr>
<tr>
<td>IV</td>
<td>3.1 (1.7)Ac</td>
<td>4.1 (2.0)Ac</td>
<td>3.1 (1.8)Ac</td>
</tr>
</tbody>
</table>

Means followed by different letters (upper case in the row and lower case in the columns) are significant different (p<0.05).

Conclusions: No statistical differences were found in PBS for different adhesive cementation techniques of relining fiber glass posts to dentin roots. PBS decreased according to increasing depth of fiber glass posts for all cementing systems tested.

3M ESPE Summary

Aim of Study: To evaluate dentin bond strength of fiber posts cemented with different adhesive cements and protocols.

Summary of Results: Although RelyX™ Unicem 2 Self-Adhesive Resin Cement is the recommended cement for fiber post cementation, this study demonstrates that both RelyX™ ARC Adhesive Resin Cement and RelyX™ Ultimate Adhesive Resin Cement can also be used to cement fiber glass posts to dentin roots. No statistical differences were found probably due to the high standard deviation of the test setup.
RelyX™ Luting Plus Automix Resin Modified Glass Ionomer Cement/
Ketac™ Cem Plus Automix Resin Modified Glass Ionomer Cement

Clinical Acceptance Survey on a RMGI Cement for Implant Restorations

E. POPP1, F. VAN VLIET1, A. FALSAFI2, T. TRAN3 and R. HAMPE1, 13M Deutschland, Dental Products, Seefeld, Germany, 23M ESPE Dental Products, Saint Paul, MN, 33M, Saint Paul, MN

In a published survey of United States dental schools on cementation protocols for implant crown restorations, most institutions reported teaching the use of definitive cements, preferably resin-modified glass ionomer cements (RMGI) as luting agent for cementing implant restorations.

Objectives: Aim of this clinical survey was to evaluate the acceptance level of a novel RMGI cement amongst Western European Dentists as cement for metal-based implant restorations.

Methods: Over a three months period, 53 Dentists were asked in a web-based clinical survey to use RelyX™ Luting Plus Automix Resin Modified Glass Ionomer Cement (RXLP, 3M ESPE) for their clinical cases according to the instructions for use. Dentists rated the performance criteria for ease of excess cement removal after five second tack-light cure per surface and its suitability for cementing metal-based implant restorations.

Results: Responses were descriptively statistically analyzed and summarized as follows:

<table>
<thead>
<tr>
<th>Satisfaction Level with Ease of Excess Removal After Tack-Curing (% Dentists)</th>
<th>Agreement Level to &quot;Due to its Easy Excess Removal After Tack-Curing, RXLP is Ideal for Permanent Cementation of Metal-Based Implant Restorations (% Dentists)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very satisfied</td>
<td>62.3</td>
</tr>
<tr>
<td>Satisfied</td>
<td>Strongly Agree</td>
</tr>
<tr>
<td>Satisfied</td>
<td>18.9</td>
</tr>
<tr>
<td>Neither-Nor</td>
<td>Agree</td>
</tr>
<tr>
<td>Neither-Nor</td>
<td>11.3</td>
</tr>
<tr>
<td>Dissatisfied</td>
<td>Neither-Nor</td>
</tr>
<tr>
<td>Dissatisfied</td>
<td>3.8</td>
</tr>
<tr>
<td>Very Dissatisfied</td>
<td>Disagree</td>
</tr>
<tr>
<td>Very Dissatisfied</td>
<td>3.8</td>
</tr>
<tr>
<td></td>
<td>Strongly Disagree</td>
</tr>
</tbody>
</table>

Additional data showed that 76.5% of all participants rated RXLP in general better than their current glass ionomer-based cement.

Conclusions: Based on this survey of 53 Western European Dentists, the acceptance level of RelyX™ Luting Plus Automix Resin Modified Glass Ionomer Cement for permanent luting of metal-based implant restorations is considered high due to its easy excess removal after tack-light-curing.

3M ESPE Summary

Aim of Study: To evaluate the acceptance of a novel RMGI for metal-based implant restorations in Western Europe.

Summary of Results: The overall acceptance of the novel RMGI for metal-based implant restorations is high what can be attributed to its easy excess removal.
RelyX™ Luting Plus Automix Resin Modified Glass Ionomer Cement/ Ketac™ Cem Plus Automix Resin Modified Glass Ionomer Cement

Clinical Evaluation of a Novel Resin-Modified Glass Ionomer Cement

R. HAMPE¹, F. VAN VLIET¹, A. FALSAFI², T. TRAN³ and E. POPP¹, ¹3M Deutschland, Dental Products, Seefeld, Germany, ²3M ESPE Dental Products, Saint Paul, MN, ³3M, Saint Paul, MN

Objectives: Aim of this clinical survey was to evaluate dentist’s satisfaction level on clinical handling properties of the novel RelyX™ Luting Plus Automix Resin Modified Glass Ionomer Cement (RXLP, 3M ESPE).

Methods: The research was conducted via a web-based survey with 53 Western European dentists over a period of three months. Participants were asked to use RXLP for their clinical cases according to the instructions for use and to rate different performance criteria on scales.

Results: Fifty-three (53) participants completed the questionnaire. Quantified responses were descriptively statistically analyzed and summarized:

<table>
<thead>
<tr>
<th>Satisfation Level with</th>
<th>Very Satisfied</th>
<th>Satisfied</th>
<th>Neither-Nor</th>
<th>Dissatisfied</th>
<th>Very Dissatisfied</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ease of Dispensing Cement</td>
<td>56.6%</td>
<td>34.0%</td>
<td>7.5%</td>
<td>1.9%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Ease of Mixing Cement</td>
<td>67.9%</td>
<td>24.5%</td>
<td>7.5%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Cement Consistency</td>
<td>45.3%</td>
<td>34.0%</td>
<td>17.0%</td>
<td>0.0%</td>
<td>3.8%</td>
</tr>
<tr>
<td>Working Time</td>
<td>55.8%</td>
<td>28.8%</td>
<td>15.4%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Cleaning Excess Cement After 5 Second Tack-Cure</td>
<td>62.3%</td>
<td>18.9%</td>
<td>11.3%</td>
<td>3.8%</td>
<td>3.8%</td>
</tr>
<tr>
<td>Self-Cure Set Time</td>
<td>35.8%</td>
<td>39.6%</td>
<td>17.0%</td>
<td>3.8%</td>
<td>3.8%</td>
</tr>
<tr>
<td>Automix Delivery System</td>
<td>58.5%</td>
<td>30.2%</td>
<td>7.5%</td>
<td>3.8%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Overall Cement Handling</td>
<td>47.2%</td>
<td>43.4%</td>
<td>9.4%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

90.6% of the respondents were satisfied or even very satisfied with the overall handling of RXLP. Additional data showed that more than 90% would recommend this cement to colleagues.

Conclusions: In a clinical survey of RelyX™ Luting Plus Automix Resin-Modified Glass Ionomer Cement, 53 dentists stated high satisfaction levels with various clinical handling properties, especially with its easy mixing and easy excess cement removal after tack-light-curing.

3M ESPE Summary

Aim of Study: To evaluate dentist’s satisfaction on clinical handling properties of the novel RelyX™ Luting Plus Automix Resin Modified Glass Ionomer Cement.

Summary of Results: This study clearly shows the very high satisfaction with the overall handling of the novel RelyX™ Luting Plus Automix Resin Modified Glass Ionomer Cement. In particular, Western European dentists appreciated the easy mixing with the automix syringe and easy excess removal after tack-cure.
RelyX™ Ultimate Adhesive Resin Cement

Long Term Adhesion of RelyX™ Ultimate Adhesive Resin Cement to Titanium

S. HADER, R. HECHT, G. RAIA and R. GUGGENBERGER, 3M ESPE Dental Products, 3M Deutschland GmbH, Seefeld, Germany

Objectives: This study investigated long term adhesion performance of RelyX™ Ultimate Adhesive Resin Cement to titanium.

Methods: Materials tested were RelyX™ Ultimate Adhesive Resin Cement in combination with Scotchbond™ Universal Adhesive (SBU) both from 3M ESPE. Shear bond strength (SBS) was tested on titanium (grade 2) slides (25 x 10 x 2mm). Stainless steel rods (4.0mm diameter, 2mm height) were cemented using RelyX™ Ultimate Adhesive Resin Cement in combination with Scotchbond™ Universal Adhesive. Titanium was pretreated according to manufacturer’s instruction by sandblasting (alumina particles 50µm). SBU was applied for 20 seconds and gently air dried for five seconds. Stainless steel rods were cemented under pressure (20g/mm²) onto titanium slides and cured for 10 minutes at 36°C. Excess was removed using a probe and remaining cement was covered with glycerin gel (AIRBLOCK™, Dentsply). Then loading weight and glycerin gel were removed. Prepared specimens were stored for 24 hours at 36°C and 100% relative humidity. SBS was measured after 24 hours (n=6). Additional specimens were stored in water at 36°C for artificial ageing and SBS was measured after three months, six months and twelve months (each group n=6). SBS was measured using a universal testing machine (Zwick Z010, crosshead speed: 0.75mm/minute).

Data obtained were analyzed using Multiple Range Test (Fisher’s LSD; p<0.05).

Results: See table. Values marked with the same superscript characters are not statistically different.

<table>
<thead>
<tr>
<th>Aging Time</th>
<th>SBS [MPa]</th>
</tr>
</thead>
<tbody>
<tr>
<td>24 Hours</td>
<td>41.4 ± 2.4A</td>
</tr>
<tr>
<td>3 Months</td>
<td>43.8 ± 3.9A</td>
</tr>
<tr>
<td>6 Months</td>
<td>51.1 ± 4.5B</td>
</tr>
<tr>
<td>12 Months</td>
<td>45.6 ± 8.1A,B</td>
</tr>
</tbody>
</table>

Conclusions: The adhesive resin cement RelyX™ Ultimate Adhesive Resin Cement shows in combination with SBU constantly high adhesion performance to titanium even after artificial ageing up to one year in the self-cure mode. The excellent performance in the self-cure mode is a key feature for successful cementation of metal based restorations including e.g. titanium implants.

3M ESPE Summary

Aim of Study: To investigate long term adhesion performance of RelyX™ Ultimate Adhesive Resin Cement to titanium.

Summary of Results: The adhesive resin cement RelyX™ Ultimate Adhesive Resin Cement in combination with the adhesive Scotchbond™ Universal Adhesive shows constantly high adhesion performance to titanium even after artificial ageing up to one year in the self-cure mode. The excellent performance in the self-cure mode is a key feature for successful cementation of metal based restorations including e.g. titanium implants.
RelyX™ Luting Plus Cement/Ketac™ Cem Plus Cement

CED
IADR 2013 CED  Abstract #455
Examination of Compressive Strength, Water Sorption and Solubility in Cements
M.A. MALKOC, Department of Prosthodontics, Inonu University, Malatya, Turkey and M. SEVIMAY, Selcuk Universitesi, Konya, Turkey

RelyX™ ARC Adhesive Resin Cement

AADR
AADR 2014  Abstract #1123
Bond Strength of Self-Adhesive Resin Cements to Chlorhexidine Treated Dentin
M. CARVAJAL, University of Costa Rica, San Jose, Costa Rica and D. LAFUENTE, University of Costa Rica, San Pedro, Costa Rica

RelyX™ Ultimate Adhesive Resin Cement

CED
IADR 2013 CED  Abstract #20
Effect of Lightcuring Through Ceramics on Shear-Bond-Strength of Adhesive Luting-Materials
K. RIST, A. STEINER-FASCHING and U. SALZ, Ivoclar Vivadent AG, Schaan, Liechtenstein

IADR 2013 CED  Abstract #469
Conversion and Acid-Base Reaction in Modern Self-Adhesive Cements
N. KOURNETAS, D. PAPADOGIANNIS and G. ELIADES, School of Dentistry, University of Athens, Department of Biomaterials, Athens, Greece

IADR 2013 CED  Abstract #522
Effect of Surface Pretreatment on Composite Onlays Bond Strength
M. CURA, I. GONZALEZ-GONZALEZ, V. GONZALEZ-GARCIA, M.V. FUENTES and L. CEBALLOS, Estomatologia, Rey Juan Carlos University, Madrid, Spain

continued on next page >
RelyX™ Unicem 2 Self-Adhesive Resin Cement

CED

IADR 2013 CED  Abstract #463
Dual Polymerization Luting Materials — An In Vitro Vickers Microhardeness Study
P. NEVES, P. MOURA, M. POLIDO and A. AZUL, Dental Materials, Centro de Investigação Interdisciplinar Egas Moniz, CiEM, Instituto Superior de Ciências da Saúde Egas Moniz, ISCSEM, Monte da Caparica, Portugal

IADR 2013 CED  Abstract #478
Effects of Irrigation Type on Push-Out Bond Strength of Carbon Post
H.C. YEGIN, Faculty of Dentistry, Yuzuncu Yil University, Van, Turkey, B. OZCOPUR, Faculty of Dentistry, Yüzüncü Yil University, Van, Turkey and S. KESKIN, Bioistatistics, Yüzüncü Yýl University, Van, Turkey

IADR 2013 CED  Abstract #492
Resin Tags Formation of Self-Adhesive Resin Cements Along Radicular Dentine
E. BAENA1, M.V. FUENTES2 and L. CEBALLOS2, 1Stomatology, Rey Juan Carlos University, Madrid, Spain, 2Estomatología, Rey Juan Carlos University, Madrid, Spain
Lava™ Ultimate Restorative

One Year Evaluation of CAD/CAM Nano-Ceramic and Leucite-Reinforced Onlays

D.J. FASBINDER, G.F. NEIVA, J.B. DENNISON, D. HEYS and R. HEYS, University of Michigan, Ann Arbor, MI

Objectives: This randomized, longitudinal clinical trial evaluated the clinical performance of chairside CAD/CAM onlays made from nano-ceramic (LU=Lava™ Ultimate Restorative/3M ESPE) and leucite-reinforced (EC=EmpressCAD/Ivoclar) materials using two adhesive cementation techniques.

Methods: Two clinicians placed 120 onlays (60 LU and 60 EC) in 86 patients: 82 in molars and 38 in premolars. The preparations were consistent with guidelines for all-ceramic onlays with a minimum of 1.5mm occlusal reduction. The CEREC AC Bluecam (Sirona) was used for image acquisition, design and milling of the onlays in a single appointment. The internal surfaces of the LU onlays were air abraded with 30 micron silica (CoJet™/3M ESPE), coated with Scotchbond™ Universal Adhesive (3M ESPE) and dried. The internal surface of the EC onlays were etched with 4.9% HFI acid, rinsed, dried and coated with a silane coupler (Monobond Plus/Ivoclar). Thirty onlays of each type were cemented with either self-etching and a dual-cure resin cement (SR=Scotchbond™ Universal Adhesive + RelyX™ Ultimate Adhesive Resin Cement/3M ESPE) or total etching and a dual-cure resin cement (EV=Excite + Variolink II/Ivoclar). Recall evaluations were at baseline, six months and one year.

Results: Seven LU onlays and five EC onlays reported mild cold sensitivity that resolved without treatment by the forth week. The onlays were evaluated by two independent examiners using modified USPHS criteria. Both LU and EC groups had 100% alpha scores for color match, margin discoloration, surface finish, anatomic form, crown fracture, caries, surface gloss and margin adaptation at baseline, six and 12 months. One EC onlay fractured at 10 months and was replaced. One LU onlay required endodontic treatment at six months.

Conclusions: Both nano-ceramic and leucite-reinforced onlays cemented with self-etching and a dual-cure resin cement or total etching and a dual-cure resin cement have performed similarly well at one year.

3M ESPE Summary

Aim of Study: Clinical performance evaluation of chairside CAD/CAM onlays made from Lava™ Ultimate Restorative and Empress CAD materials. Lava™ Ultimate Restorative onlay restorations were cemented with RelyX™ Ultimate and Scotchbond™ Universal Adhesive in self-etching mode. Empress CAD materials were cemented with Variolink II with Excite in total-etch mode.

Summary of Results: Lava™ Ultimate Restorative with RelyX™ Ultimate with Scotchbond™ Universal Adhesive in self-etch mode performed similarly well at one year compared with Empress CAD with Variolink II and Excite in total-etch mode.
Lava™ Ultimate Restorative

Color Stability of Esthetic Materials After Storage in Different Media

P.F. CESAR, E. LIMA, M.C. VILLAÇA, L.H. SILVA, L.L. ARASHIRO, F.A. PEREIRA and W.G. MIRANDA JR., University of São Paulo, São Paulo, Brazil

Objectives: To determine the color difference (DE) of esthetic restorative materials after immersion in water, wine and coffee for 60 days.

Methods: Three resin composites were used, two for indirect (Lava™ Ultimate Restorative/3M ESPE and Signum/Heraeus-Kulzer) and one for direct restorations (Empress-Direct/Ivoclar). Fifteen blocks (6 x 8 x 2mm) of each material were produced according to manufacturers instructions and both wider sides were polished (1µm). Specimens were divided into three groups (water, red wine and coffee). L*a*b* parameters were measured immediately after polishing (control) and after 60 days of storage using a spectrophotometer (transmittance mode/lambda range 400–700nm/10nm-interval). Fixed parameters were: illumination CIE/D65 (day light/6500K) and observer at two degrees. E was determined by: $E = \sqrt{(Lc*-Ls*)^2+(ac*-as*)^2+(bc*-bs*)^2}$, where c/s indicate measurements on the control and after storage, respectively. The values of E (clinically relevant threshold between three and five) were subjected to two-away ANOVA and Tukey test (alpha=0.05).

Results: The materials tested responded differently to the three immersion media. The DE values measured for Lava™ Ultimate Restorative and Signum were not significantly affected by the storage media after the maximum storage time (see Table, mean of DE ± standard deviation). For Empress Direct, immersion in wine resulted in significantly higher DE mean value in comparison to that obtained after immersion in water. For this material, although immersion in coffee resulted in higher DE in comparison to water, this difference was not statistically significant. Only the DE values obtained for Empress Direct in wine and coffee were above the clinically significant limit, meaning that such color difference can be noted by trained observers.

<table>
<thead>
<tr>
<th>Material</th>
<th>Water</th>
<th>Wine</th>
<th>Coffee</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lava™ Ultimate Restorative</td>
<td>2.4 ± 0.3c</td>
<td>1.6 ± 0.8c</td>
<td>3.8 ± 0.9bc</td>
</tr>
<tr>
<td>Empress Direct</td>
<td>3.0 ± 1.0bc</td>
<td>7.1 ± 2.1c</td>
<td>5.1 ± 0.7ab</td>
</tr>
<tr>
<td>Signum</td>
<td>2.2 ± 0.8c</td>
<td>2.8 ± 1.4c</td>
<td>2.6 ± 0.7c</td>
</tr>
</tbody>
</table>

Conclusions: Color stability of the direct composite in wine was inferior in comparison to indirect materials. Immersion in coffee did not significantly affect the color of materials tested in comparison to immersion in water.

3M ESPE Summary

Aim of Study: Evaluate and measure color changes for samples of Lava™ Ultimate Restorative, Signum and Empress Direct restorations after 60 days of storage in water, red wine and coffee.

Summary of Results: Lava™ Ultimate Restorative shows good color stability in comparison to direct composite material, Empress Direct.
Lava™ Plus High Translucency Zirconia

Zirconia Phase Transformation Kinetic and Clinical Relevance

C.F. NORMAN1, H. HAUPTMANN2, R. DITTMANN3, B. THEELKE2, G. SCHECHNER3, V.A. RUSSELL1 and J. ROLF1, 13M ESPE Dental Products, Saint Paul, MN, 23M Deutschland GmbH, Seefeld, Germany, 33M ESPE Dental Products, Seefeld, Germany

Objectives: Three commercially available dental zirconia materials were hydrothermally treated up to extreme long durations of 150 hours. Changes in surface crystal phases, fracture strength and hardness were measured.

Methods: Lava™ Frame Zirconia (LF), Lava™ Plus High Translucency Zirconia (LP) (3M ESPE) and BruxZir HT2.0 (BZ) (Glidewell) were cut, sintered according to recommended sintering cycles, ground and polished to slices (XRD) and bars of 3 x 4 x 45mm (strength and hardness). Samples were treated up to 150 hours in an autoclave at 134°C and two bar water vapor. At each treatment stage crystal phase content was measured by XRD (n=3, Bruker D8-Discover). Four-point flexural strength (20mm/40mm span, 1mm/second, n=15) and Vickers Hardness via Micro Hardness Testing System (Leco) were measured initially and at comparable monoclinic phase contents. All fracture strength tests have been analyzed and compared by Weibull statistics.

Results:

<table>
<thead>
<tr>
<th>Material</th>
<th>Duration (Hours)</th>
<th>Tetragonal (wt.%)</th>
<th>Cubic (wt.%)</th>
<th>Disorted Phase (c2) (wt.%)</th>
<th>Monoclinic (wt.%)</th>
<th>Weibull Strength (MPa)</th>
<th>Weibull Modulus (–)</th>
<th>Vickers Hardness 0.1HV15</th>
</tr>
</thead>
<tbody>
<tr>
<td>LF</td>
<td>0</td>
<td>54</td>
<td>13</td>
<td>32</td>
<td>2</td>
<td>1231</td>
<td>15</td>
<td>1387</td>
</tr>
<tr>
<td></td>
<td>2.5</td>
<td>54</td>
<td>13</td>
<td>32</td>
<td>2</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>54</td>
<td>13</td>
<td>32</td>
<td>2</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>54</td>
<td>12</td>
<td>32</td>
<td>3</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>54</td>
<td>12</td>
<td>31</td>
<td>3</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>54</td>
<td>13</td>
<td>27</td>
<td>6</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>53</td>
<td>14</td>
<td>23</td>
<td>10</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>75</td>
<td>47</td>
<td>17</td>
<td>20</td>
<td>16</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>89</td>
<td>41</td>
<td>18</td>
<td>19</td>
<td>22</td>
<td>1090</td>
<td>25</td>
<td>1104</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>41</td>
<td>17</td>
<td>19</td>
<td>23</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>150</td>
<td>23</td>
<td>17</td>
<td>22</td>
<td>38</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>157</td>
<td>17</td>
<td>16</td>
<td>23</td>
<td>44</td>
<td>1027</td>
<td>36</td>
<td>1012</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>53</td>
<td>12</td>
<td>33</td>
<td>3</td>
<td>1176</td>
<td>12</td>
<td>1364</td>
</tr>
<tr>
<td></td>
<td>2.5</td>
<td>53</td>
<td>12</td>
<td>33</td>
<td>3</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>53</td>
<td>12</td>
<td>33</td>
<td>3</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>53</td>
<td>11</td>
<td>33</td>
<td>3</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>53</td>
<td>11</td>
<td>33</td>
<td>3</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>54</td>
<td>12</td>
<td>29</td>
<td>5</td>
<td>1211</td>
<td>12</td>
<td>1299</td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>53</td>
<td>17</td>
<td>21</td>
<td>10</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>75</td>
<td>45</td>
<td>15</td>
<td>20</td>
<td>19</td>
<td>1034</td>
<td>23</td>
<td>1066</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>32</td>
<td>16</td>
<td>20</td>
<td>32</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>117</td>
<td>17</td>
<td>18</td>
<td>20</td>
<td>45</td>
<td>1007</td>
<td>15</td>
<td>1005</td>
</tr>
<tr>
<td></td>
<td>150</td>
<td>7</td>
<td>13</td>
<td>25</td>
<td>55</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>63</td>
<td>15</td>
<td>22</td>
<td>0</td>
<td>1136</td>
<td>7</td>
<td>1397</td>
</tr>
<tr>
<td></td>
<td>2.5</td>
<td>63</td>
<td>15</td>
<td>21</td>
<td>1</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>63</td>
<td>15</td>
<td>19</td>
<td>3</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>56</td>
<td>15</td>
<td>18</td>
<td>15</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>22</td>
<td>18</td>
<td>18</td>
<td>42</td>
<td>1096</td>
<td>20</td>
<td>1372</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>11</td>
<td>4</td>
<td>21</td>
<td>64</td>
<td>1026</td>
<td>16</td>
<td>885</td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>15</td>
<td>4</td>
<td>17</td>
<td>64</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>75</td>
<td>15</td>
<td>4</td>
<td>17</td>
<td>64</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>15</td>
<td>4</td>
<td>16</td>
<td>65</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>150</td>
<td>15</td>
<td>4</td>
<td>16</td>
<td>65</td>
<td>13</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Crystal phase content, fracture strength and hardness depending on hydrothermal treatment time.
Conclusions: The crystal phase transformation kinetics of LF and LP are slower compared to BZ. BZ transformed to a maximum monoclinic content above 60 wt% after 30 hours, whereas LF and LP reached approximately 5 wt% monoclinic after the same time. After hydrothermal treatment of 15 hours, BZ shows a higher monoclinic content and a lower strength (42 wt%, 1096 MPa, m=20) compared to LF (3 wt%, 1285 MPa, m=13) and LP (3 wt%, 1270 MPa, m=13).

At comparable monoclinic surface phase content of about 40 wt%, Weibull strength was higher than 1000 MPa for all tested materials, however this phase transformation was reached after different treatment times (LF 157 h, 1027 MPa, m=36 / LP=117 h, 1007 MPa, m=15 / BZ=15 h, 1096 MPa, m=16). Surface hardness decreased with increasing hydrothermal treatment time for all three materials.

Different dental zirconia show different transformation kinetics, however monoclinic surface phase did not show a considerable impact on strength as one of the most important clinical relevant material properties.

3M ESPE Summary

Aim of Study: To investigate the hydrothermal stability of three different dental zirconia materials as measured by the tetragonal to monoclinic phase transformation, four-point bend fracture strength and Vickers micro-hardness tests.

Summary of Results: Lava™ Frame Zirconia and Lava™ Plus High Translucency Zirconia were shown to undergo slower low temperature phase transformation compared to BruxZir HT2.0.
Lava™ Ultimate Restorative

Light Energy Transmission Through Various Thicknesses of a CAD/CAM Material

C.E. SABROSA1, R.H. MARCHIORI1, L. LAXE1 and C. FELIX2, 1University of the State of Rio de Janeiro, Rio de Janeiro, Brazil, 2BlueLight analytics inc, Halifax, NS, Canada

Objectives: Background introduction: The amount of light energy that reaches the cement depends on light irradiance of the light curing unit (LCU), the thickness and the shade of the restoration. The objective of this study was to quantify the amount of energy transmission through one shade of a CAD/CAM material in five different thicknesses using one light-emitting diode (LED) LCU.

Methods: An LED LCU (Elipar™ S10 LED Curing Light; 3M ESPE, Seefeld, Germany) was mounted on a Marc® Resin Calibrator (BlueLight Analytics Inc., Halifax, NS, Canada) and tested at 0.0mm with no specimen (group 1). The LCU was set for 10 seconds of exposure following manufacture’s recommendation. Three specimens measuring group 2) 0.5mm; group 3) 1.0mm; group 4) 1.5mm; group 5) 2.0mm and group 6) 3.0mm of A2-HT shaded blocks of a resin-nano ceramic CAD/CAM material (Lava™ Ultimate Restorative) were fabricated. The amount of light transmission was calculated for all thicknesses. Measurements were repeated three times for each specimen. Means and standard deviations were calculated. Results were analyzed with ANOVA followed by Tukey HSD test (α=0.05).

Results: Means and standard deviations of light transmission (mW/cm²) were: group 1 (1971.88 ± 4.73); group 2 (1121.96 ± 80.68); group 3 (660.36 ± 40.96); group 4 (439.48 ± 10.93); group 5 (298.70 ± 16.87) and group 6 (138.74 ± 6.51). There was a statistical significant difference of light transmission through all different thicknesses.

Conclusions: Within the limitations of this study, results determined that the energy delivered at the intaglio of a restoration made from the studied material in one particular shade decreases as the thickness of the restoration increases. Attention should be paid to prolong light curing times (even with LED curing units providing high irradiances) when light curing resin cements through thick resin-nano ceramic restorations.

3M ESPE Summary

Aim of Study: Quantify the amount of light energy transmission through Lava™ Ultimate Restorative (A2-HT) in five different thicknesses using 3M™ ESPE™ Elipar™ S10 LED Curing Light.

Summary of Results: Light transmission was statistically significantly different with different thicknesses of material. Attention should be paid to proper light curing times when light curing resin cements through thick resin-nano ceramic restorations.
Lava™ Ultimate Restorative

The Effect of Surface Treatments on Roughness of CAD/CAM Materials

Y.E. MERAL and N. ANIL, Hacettepe University, Ankara, Turkey

Objectives: To evaluate the influence of different surface treatments on the surface roughness (SR) of three different CAD/CAM materials (Nanocomposite, Hybrid and Feldspathic ceramic).

Methods: Fifty-four ceramic plates of 7 x 7 x 1mm sized from each blocks, Nanocomposite CAD/CAM block (Lava™ Ultimate Restorative, 3M ESPE), Hybrid (VITA Enamic, VITA/Zahnfabrik) and Feldspathic (CEREC Bloc, Sirona) were prepared. Samples were divided into six groups according to surface treatments as follows: (1) Control Group (No Treatment), (2) Airborne particle abrasion (APA) with 110µm Al2O3, (3) Tribochemical method (CoJet™, 3M ESPE), (4) Acid etching with 5% HF, (5) Acid etching with 10% HF, (6) Nd:YAG Laser irradiation.

Following surface treatments, SR of samples were measured, the morphological characteristics were observed.

SR (Ra in micrometer) measurements were performed on each sample using a surface profilometer (Perthometer, Mahr, Gottingen, Germany) with a cutoff value of 1mm and measuring length of 5mm. From the three measurements per sample were calculated and averaged. In order to perform a qualitative micromorphologic examination of ceramic surfaces, one specimen from each group was randomly selected and specimens were evaluated with SEM (JSM-6400 SEM, JEOL, Tokyo, Japan) at 50x and 200x magnifications. One-way ANOVA test was performed as the statistical analyses for SR (p=0.05).

Results: APA and CoJet™ showed significantly higher SR values compared to other surface treatments (p<0.05), however, the difference between APA and CoJet™ were negligible for nanocomposite. APA showed the higher SR measurements for hybrid ceramic (p<0.05), for other surface treatments, no significant difference was observed. SR values for feldspathic were lower than the others and no significant difference was observed for any of the surface treatments (p>0.05). SEM observations revealed cracks and defects on material surfaces.

Conclusions: Higher SR levels can be obtained by the application of APA for all of the CAD/CAM materials tested in this study. However, nanocomposite and hybrid ceramic surfaces can be affected by the surface treatments more than feldspathic ceramic.

3M ESPE Summary

Aim of Study: Surface roughness (SR) of Lava™ Ultimate Restorative was compared to VITA® Enamic and VITA® CEREC Bloc (feldspathic) after various surface treatments (1) Control (no treatment), (2) Airborne particle abrasion with 110µm Al2O3, (3) CoJet™ 30µm Al2O3 with SiO2, (4) Acid etching with 5% HF, (5) Acid etching with 10% HF, (6) Nd: YAG laser.

Summary of Results: Higher surface roughness is obtained with airborne particle abrasion using 3M™ ESPE™ CoJet™ (30µm Al2O3 with SiO2). Airborne particle abrasion with 3M™ ESPE™ CoJet™ is the recommended surface treatment procedure for use with Lava™ Ultimate Restorative.

Reprinted with permission from the Journal of Dental Research. J Dent Res 93 (Spec Iss B): 301
https://jdr.econdex.com/jdr/43am/webprogram/start.html
Lava™ Plus High Translucency Zirconia

Roughness and Crystal Phase of Zirconia after Long-Term Hydrothermal Treatment

B. THEELKE, R. DITTMANN, A. SCHMALZL and H. HAUPTMANN, RDD, 3M Deutschland GmbH, Seefeld, Germany

Objectives: Aim of this study is to investigate the aging kinetic of three commercial available dental Zirconia materials regarding surface crystal phases and surface roughness for extreme long accelerated aging durations up to 150 hours.

Methods: Lava™ Frame Zirconia (LF), Lava™ Plus High Translucency Zirconia (LP) (3M ESPE) and BruxZir HT2.0 (BZ) (Gladewell) were cut, sintered according recommended sintering cycles, ground and polished to slices for XRD and roughness measurement. The samples were hydrothermally aged in an autoclave to specific durations at 134°C and two bar. After every aging duration monoclinic, tetragonal, cubic and distorted crystal phase content was measured by XRD (n=3, Bruker D8-Discover). Surface roughness was measured by 3D Laser-Scanning-Microscope (Keyence VK-9710) on identical positions (n=1).

Results:

<table>
<thead>
<tr>
<th>Material</th>
<th>Duration Accelerated Hydrothermal Treatment (Hours)</th>
<th>Monoclinic Mean (wt.%)</th>
<th>Monoclinic Stdv (wt.%)</th>
<th>Roughness Ra (µm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LF</td>
<td>0</td>
<td>2</td>
<td>0.0</td>
<td>0.050</td>
</tr>
<tr>
<td></td>
<td>2.5</td>
<td>2</td>
<td>0.0</td>
<td>0.051</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>2</td>
<td>0.0</td>
<td>0.051</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>3</td>
<td>0.0</td>
<td>0.048</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>3</td>
<td>0.0</td>
<td>0.051</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>6</td>
<td>0.0</td>
<td>0.052</td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>10</td>
<td>0.0</td>
<td>0.053</td>
</tr>
<tr>
<td></td>
<td>75</td>
<td>16</td>
<td>0.0</td>
<td>0.056</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>23</td>
<td>0.6</td>
<td>0.083</td>
</tr>
<tr>
<td></td>
<td>150</td>
<td>38</td>
<td>1.7</td>
<td>0.085</td>
</tr>
<tr>
<td>LP</td>
<td>0</td>
<td>3</td>
<td>0.6</td>
<td>0.042</td>
</tr>
<tr>
<td></td>
<td>2.5</td>
<td>3</td>
<td>0.6</td>
<td>0.040</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>3</td>
<td>0.6</td>
<td>0.041</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>3</td>
<td>0.6</td>
<td>0.040</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>3</td>
<td>0.0</td>
<td>0.043</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>5</td>
<td>0.6</td>
<td>0.035</td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>10</td>
<td>2.1</td>
<td>0.051</td>
</tr>
<tr>
<td></td>
<td>75</td>
<td>19</td>
<td>3.2</td>
<td>0.081</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>32</td>
<td>3.5</td>
<td>0.064</td>
</tr>
<tr>
<td></td>
<td>150</td>
<td>55</td>
<td>0.6</td>
<td>0.061</td>
</tr>
<tr>
<td>BZ</td>
<td>0</td>
<td>0</td>
<td>0.0</td>
<td>0.043</td>
</tr>
<tr>
<td></td>
<td>2.5</td>
<td>1</td>
<td>0.0</td>
<td>0.043</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>3</td>
<td>0.0</td>
<td>0.042</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>15</td>
<td>1.0</td>
<td>0.058</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>42</td>
<td>1.5</td>
<td>0.090</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>64</td>
<td>0.6</td>
<td>0.066</td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>64</td>
<td>0.0</td>
<td>0.065</td>
</tr>
<tr>
<td></td>
<td>75</td>
<td>64</td>
<td>0.0</td>
<td>0.067</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>65</td>
<td>0.6</td>
<td>0.095</td>
</tr>
<tr>
<td></td>
<td>150</td>
<td>65</td>
<td>0.6</td>
<td>0.074</td>
</tr>
</tbody>
</table>

Table 1: Results for surface crystal phase content and roughness depending on hydrothermal treatment time.
Conclusions: The aging stability of LF and LP is higher than the aging stability of BZ. The surface phase transformation of BZ achieved a maximum monoclinic content above 60 wt.% after 30 hours accelerated aging whereas LZ and LP show approximately 5 wt.% monoclinic after the same time. With increasing monoclinic phase content surface roughness Ra changes only few nanometers after 150 hours accelerated aging for all tested materials. In contrast surface grinding with red ring diamond of a polished Zirconia surface increases roughness Ra from 0.20 µm to 1.49µm. Therefore manual surface treatments like grinding and polishing are more important for clinical performance of Zirconia materials in terms of wear and defect free surfaces than hydrothermal aging. It is expected that the measured increase of roughness even after long-term accelerated hydrothermal aging is not critical in clinical practice.

3M ESPE Summary

Aim of Study: To investigate the hydrothermal stability of three different dental zirconia materials as measured by changes in the crystal phase assemblage and surface roughness.

Summary of Results: Lava™ Frame Zirconia and Lava™ Plus High Translucency Zirconia were shown to undergo slower low temperature phase transformation compared to BruxZir HT2.0.
In Vitro Wear Behavior of Dental Restoration Materials

R. DITTMANN⁴, M. URBAN⁴, A. HERRMANN⁴, R. GUGGENBERGER⁵ and A. VIEHBECK³, ¹²3M ESPE Dental Products, Seefeld, Germany, ³3M Deutschland GmbH, Seefeld, Germany, ²³M ESPE, 3M Deutschland GmbH, Seefeld, Germany

Objectives: In this study the wear behavior of various restoration materials against each other has been investigated with an in vitro test setup. The results could give an indication what abrasion characteristics can be observed, if patients have restorations of different material classes on opposing tooth positions.

Methods: Spheres and substrate samples of various dental restoration materials were fixed in a longitudinal moving abrasion test device (Elcometer 1720). Spheres were slid under water across material plates at a constant load of 5 N (path length 10mm, 120 cycles/minute for 120 minutes). Spheres (Ø 6mm) and plate like substrate materials (l=40mm, w=20mm, h=3mm) were prepared from following material classes: reference Steatite (Ceramtec), 3M™ ESPE™ Lava™ Ultimate (LU), 3M ESPE experimental veneering material (VM), 3M™ ESPE™ Lava™ Plus High Translucency Zirconia (LPZ). All spheres and substrates were polished with diamond polishers prior to the abrasion experiment. All combinations of sphere and substrate materials have been tested (n=4). Sphere abrasion was measured by microscopy (Zeiss SV11) and volume loss (Vloss) was calculated.

Results: Vloss of spheres is presented in attached diagram. Steatite was used as an enamel model material. Two sample t-tests (p<0.05) have been performed for all material combinations to the reference combination with Steatite sphere on Steatite substrate.

Conclusions: Vloss of all tested spheres on LU as substrate material was statistically significant lower compared to the Steatite reference group. On LPZ as substrate the Vloss of the tested materials was statistically significant lower for LPZ and not statistically different for Steatite, LU and VM compared to the Steatite reference combination. Vloss of LPZ spheres was lowest on all tested substrate materials. VM has statistically significant higher abrasion compared to the Steatite reference and has shown the highest Vloss on the Steatite substrate and second highest on VM substrate.

continued on next page>
Lava™ Plus Zirconia/Lava™ Ultimate Restorative (cont.)

3M ESPE Summary

**Aim of Study:** To study the wear of various materials against each other in a 2-body abrasion resistance test.

**Summary of Results:** The lowest wear rate for all antagonist spheres was when Lava™ Ultimate Resin Nano Ceramic was the substrate with Lava™ Plus Zirconia being next. Lava Plus Zirconia antagonist spheres showed the lowest wear rates when abraded against all the substrates studied.
Fracture Strength of CAD/CAM Crowns Over Posterior Dental Implants

Y. TORREALBA, University of Alberta, Edmonton, AB, Canada

Objectives: The aims of this study were to: 1. Compare the fracture strengths of two computer-aided design/computer-aided manufacturing (CAD/CAM) crown systems: Lava™ Ultimate Restorative (Resin Nano Ceramic) and E-max (Monolithic lithium disilicate) and 2. Evaluate the failure mode of the restorations.

Methods: A total of 40 Tatum system titanium implant abutments for molar were used for all-ceramic crowns. Twenty Lava™ Ultimate Restorative crowns and twenty e-max crowns were fabricated for lower molar tooth using the E4D computer-aided design/computer-assisted manufacture (CAD/CAM) system. All crowns were cemented to the abutments, which were connected to implant fixtures, using resin cement. Fracture load was applied through a 5mm diameter composite resin sphere (Z100™ Restorative, 3M ESPE) and was measured using the ElectroForce 3100 test instrument (Bose). Due to their identical occlusal anatomy, all specimens could be positioned in the same reproducible location with the sphere contacting the inner slope of the buccal and lingual cusps. The fracture surface was evaluated by X400 electron microscopy.

Results: The e.max group showed higher fracture load (3100.1 N) compared with the Lava™ Ultimate Restorative group (2830.3 N). All fractures in both group occurred in the porcelain body, some of the e-max group experienced a complete fracture from the central fossa on which the load was applied. Fracture mode was consistent for all Lava™ Ultimate Restorative groups.

Conclusions: Both E-max (monolithic CAD/CAM lithium disilicate) crowns and Lava™ Ultimate Restorative (resin nano ceramics) crowns are applicable to posterior implant-supported restorations because the fracture load was higher than the average occlusal load.

3M ESPE Summary

Aim of Study: Compare the fracture strengths of Lava™ Ultimate Restorative with e.max CAD restorative and evaluate the failure mode of the restorations.

Summary of Results: Lava™ Ultimate Restorative crowns are applicable to posterior implant-supported restorations because the fracture load (2830.3 N) was higher than the average occlusal load.
Long-Term Bond Effectiveness of CAD/CAM Ceramic-Reinforced Polymer

A. KASHKARI1, J. PHARK2, N. SARTORI2, C. JURADO1, C. AMARILLAS1 and S. DUARTE2, 1Advanced Program in Operative and Esthetic Dentistry — Ostrow School of Dentistry of University of Southern California, Los Angeles, CA, 2Ostrow School of Dentistry of University of Southern California, Los Angeles, CA

Objectives: To evaluate the influence of sandblasting, cleaning and silanes on long-term bond strength of a resin cement to ceramic-reinforced polymer.

Methods: Twenty-four sectioned blocks (14 x 14 x 4mm) of Lava™ Ultimate Restorative (3M ESPE) were divided into two groups based on surface treatment (sandblasted or not sandblasted). Half of each group was left uncleaned (Not etched), the other half was cleaned by etching with 37% phosphoric acid for 60 seconds. Then each subgroup was divided according to the type of silane used (no silane, RelyX™ Ceramic Primer (3M ESPE), Clearfil Ceramic Primer [Kuraray]). Composite discs (Paradigm™ MZ100 Block, 3M ESPE) with 5mm thickness and 14mm diameter were cemented to the Lava™ Ultimate Restorative blocks using a dual-cure resin cement (RelyX™ Ultimate Adhesive Resin Cement, 3M ESPE). All samples were subjected to artificial ageing (20,000 thermal cycles) and then processed for micro-tensile bond strength testing. Sticks with a cross sectional area of 0.8 ± 0.2mm² were fractured under tension at a crosshead speed of 1mm/minute. Data were submitted to three-way ANOVA and Bonferroni post-hoc tests (α=0.05). In addition, samples of each group were processed for SEM.

Results: Means with identical superscript lower-case letters in the same column (comparing silanes) and identical superscript upper-case letters in the same row (comparing etching and sandblasting) are not significantly different (p>0.05).

<table>
<thead>
<tr>
<th>Silane</th>
<th>No Sandblasting</th>
<th>Sandblasting</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Not Etched</td>
<td>Etched</td>
</tr>
<tr>
<td>No Silane</td>
<td>(30/0) 80.83 ± 13.5A</td>
<td>(30/0) 47.63 ± 12.7B</td>
</tr>
<tr>
<td>RelyX Ceramic Primer</td>
<td>(33/0) 91.39 ± 21.1A</td>
<td>(32/0) 94.31 ± 22.5B</td>
</tr>
<tr>
<td>Clearfil Ceramic Primer</td>
<td>(47/0) 89.34 ± 20.5B</td>
<td>(32/0) 94.19 ± 23.7B</td>
</tr>
</tbody>
</table>

Conclusions: Silanization is an essential step to provide long-term bond effectiveness to CAD/CAM ceramic-reinforced polymer. Furthermore, sandblasting increases bond strength while etching does not.

3M ESPE Summary

Aim of Study: To evaluate the influence of sandblasting, cleaning with phosphoric acid and silanization of Lava™ Ultimate Restorative on microtensile bond strength after artificial aging (20,000 thermal cycles).

Summary of Results: Proper sandblasting and silanization is essential to provide long-term bonding effectiveness for Lava™ Ultimate Restorative.
Lava™ Ultimate Restorative

Shear Bond Strength of a New Resin Nanoceramic CAD/CAM Material

V.A. RUSSELL, R.P. RUSIN, R.A. BOEHMER and M.B. GUSTAFSON, 3M ESPE Dental Products, Saint Paul, MN

Objectives: The notched-edge shear bond strength (SBS) of a new resin nanoceramic CAD/CAM material to bovine dentin was studied. Variables investigated were adhesive etch mode (total etch/TEA or self etch/SEA) and cement cure mode (light cure/LCC or self cure/SCC). The adhesive for the cement system was light cured on dentin.

Materials: All manufactured by 3M ESPE: Lava™ Ultimate CAD/CAM Restorative A2LT (LVU), Scotchbond™ Universal Adhesive (SBU), Scotchbond™ Universal Etchant (SBE), RelyX™ Ultimate Adhesive Resin Cement (RXU).

Methods: CAD/CAM Material: LVU button (4mm diameter x 2mm height) bonding surface sandblasted and primed with SBU per manufacturer’s IFU. Adhesive on bovine dentin substrate: TEA mode: dentin etched with SBE per manufacturer’s IFU. SEA mode: no etchant used. TEA and SEA modes: SBU applied to dentin, air dried and light cured per manufacturer’s IFU. Cement: RXU applied to LVU button. Button fixtureed onto light-cured-adhesive dentin surface with applied pressure of 20g/mm². LCC mode: fixtured samples light cured from two sides of button. SCC mode: fixtured samples stored at 37°C/97% RH for 20 minutes. All bonded samples stored in 37°C water for 24 hours prior to testing. Testing: samples tested using notched-edge shear fixture, Instron crosshead speed 1mm/minute. For each group, n=10.

Results: Mean SBS are listed in the table. Data analyzed using two-way ANOVA (p<0.05); adhesive etch mode was not significant (p=0.631) and cement cure mode was significant (p=0.011).

<table>
<thead>
<tr>
<th>Adhesive Etch Mode</th>
<th>Cement Cure Mode</th>
<th>SBS(StdDev), MPa</th>
</tr>
</thead>
<tbody>
<tr>
<td>TEA</td>
<td>LCC</td>
<td>16.8 (4.1)</td>
</tr>
<tr>
<td>SEA</td>
<td>LCC</td>
<td>17.9 (4.8)</td>
</tr>
<tr>
<td>TEA</td>
<td>SCC</td>
<td>12.4 (8.3)</td>
</tr>
<tr>
<td>SEA</td>
<td>SCC</td>
<td>12.9 (3.7)</td>
</tr>
</tbody>
</table>

Conclusions: Light curing of cement (LCC) resulted in statistically higher SBS vs. self curing of cement (SCC). There were no statistical differences in SBS for adhesive etch mode (TEA vs. SEA), suggesting that total etch or selective enamel etch techniques (where dentin is in self-etch mode) may be used without affecting bond strength.

3M ESPE Summary

Aim of Study: To investigate the shear bond strength of Lava™ Ultimate CAD/CAM Restorative to bovine dentin in dependency on different etch and cure modes of RelyX™ Ultimate Adhesive Resin Cement.

Summary of Results: Light curing of RelyX™ Ultimate Adhesive Resin Cement resulted in statistically higher shear bond strength than self curing whereas total etch technique seemed to have less of an influence.
Impact Strength of Five Different CAD/CAM Material Classes

A. HERRMANN1, G. SCHECHNER1, R. DITTMANN1, E. MECHER1, R. GUGGENBERGER2, A. VIEHBECK2 and H. HAUPTMANN3, 13M ESPE Dental Products, Seefeld, Germany, 23M ESPE, 3M Deutschland GmbH, Seefeld, Germany, 33M Deutschland GmbH, Seefeld, Germany

Objectives: This investigation compares the impact strength of a resin nano ceramic, hybrid dental ceramic, leucite reinforced glass-ceramic, lithium-disilicate glass ceramic and microfiller reinforced polyacrylic material.

Methods: Impact strength of a material indicates the absorbed energy of a material during fracture. Impact strength of Lava™ Ultimate Restorative (3M ESPE), VITA Enamic (VITA Zahnfabrik), IPS Empress CAD (Ivoclar Vivadent), IPS e.max CAD (Ivoclar Vivadent) and VITA CAD-Temp (VITA Zahnfabrik) was measured in accordance to EN-ISO 179-1:2010. The measurement was performed on flexural strength bars (10 x 3 x 16mm; at least n=5 for each material) in a 3-point-bending geometry (span width=2mm). Materials were prepared according their instructions for use and surfaces were polished to a specific surface roughness. The measurement was done on an impact strength tester (Fa. Zwick/Roell) consisting a pendulum of 0.5 Joule. Data were analyzed with one-way ANOVA and Tukey’s t-test (p<0.05).

Results: The table shows the mean impact strength values and standard deviation in kJ/m² for all tested materials. Letters indicate groups that are not statistically different.

<table>
<thead>
<tr>
<th>Material</th>
<th>Material Class</th>
<th>Impact Strength with Standard Deviation in kJ/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lava™ Ultimate Restorative</td>
<td>Resin nano ceramic</td>
<td>7.54 ± 1.62 (A)</td>
</tr>
<tr>
<td>Vita Enamic</td>
<td>Hybrid dental ceramic</td>
<td>2.13 ± 0.20 (B)</td>
</tr>
<tr>
<td>Empress CAD</td>
<td>Leucite reinforced glass-ceramic</td>
<td>1.38 ± 0.32 (B)</td>
</tr>
<tr>
<td>IPS e.max CAD</td>
<td>Lithium-disilicate glass ceramic</td>
<td>2.34 ± 0.78 (B)</td>
</tr>
<tr>
<td>Vita CAD Temp</td>
<td>Microfiller Reinforced Polyacrylic</td>
<td>1.60 ± 0.12 (B)</td>
</tr>
</tbody>
</table>

Conclusions: Within this investigation Lava™ Ultimate Restorative showed statistical significant higher impact strength than IPS e.max CAD, Empress CAD, Vita Enamic and Vita CAD Temp.

3M ESPE Summary

Aim of Study: Compare the impact strength of a Lava™ Ultimate Restorative with hybrid ceramic, leucite reinforced glass-ceramic, lithium-disilicate glass ceramic, and microfiller reinforced polyacrylic materials.

Summary of Results: Lava™ Ultimate Restorative showed statistical significant higher impact strength than IPS e.max CAD, Empress CAD, Vita Enamic and Vita CAD Temp.
**Objectives:** This study determined radiopacity of different non-metallic CAD/CAM blocks.

**Methods:** Two specimens 2.0 ± 0.05mm thick were cut from nine different CAD/CAM blocks (IPS-Empress-CAD, IPS-Emax-CAD, Lava™ Ultimate Restorative, Pro-CAD, Pro-CAD-Bleach, Paradigm™ MZ100, Telio, Vitablocks-Mark-II, IPS-Emax-ZirCAD) using low-speed saw. Longitudinal sections of same thickness were also obtained from recently-extracted permanent molar and premolar for comparison. Specimens were assigned to two groups. One group had molar section with 10 specimens while other had premolar with remaining 10 specimens. Each group was placed on digital radiograph sensor (Schick CDR, size 2) together with aluminum step wedge. Following standardized technique sensor was exposed to X-ray of 65kVp and 4mA for 0.125 second exposure time with object-film distance of 120mm. Two images were obtained from each group. Images were analyzed using ImageJ software to determine number of pixels at 5 different locations of each specimen. A total of 20 readings were obtained per material. Means and SDs were calculated and data statistically-analyzed with one-way ANOVA and Tukey's tests. Radiopacity values of the materials were expressed as equivalent of aluminum thickness.

**Results:** ANOVA revealed a significant difference in mean pixels among the materials (p<.001). IPS-Emax-ZirCAD had highest mean pixel reading which was significantly higher than all other materials (p<.001) followed by two composite-based blocks (Paradigm™ MZ100 and Lava™ Ultimate Restorative). All three blocks had mean pixel values higher than that of enamel. Pro-CAD, Pro-CAD-Bleach, IPS-Empress-CAD, IPS-Emax-CAD had mean pixel values between those of enamel and dentin while Vitablocks-Mark-II had mean value less than that of dentin and Telio was non-detectable.

**Conclusions:** IPS-Emax-ZirCAD, Paradigm™ MZ100 and Lava™ Ultimate Restorative blocks were found to have high radiopacity values that will allow easy detection on radiographs. Whereas Pro-CAD, Pro-CAD-Bleach, IPS-Empress-CAD, IPS-Emax-CAD had values falling between those of enamel and dentin and Vitablocks-Mark-II had mean value significantly lower than that of dentin which may not be sufficient for diagnostic purposes.

**3M ESPE Summary**

**Aim of Study:** Evaluate and measure radiopacity of 9 different CAD/CAM blocks: IPS-Empress-CAD, IPS-Emax-CAD, Lava™ Ultimate Restorative, Pro-CAD, Pro-CAD-Bleach, Paradigm™ MZ100, Telio, Vitablocks-Mark-II, IPS-Emax-ZirCAD.

**Summary of Results:** Lava™ Ultimate Restorative and Paradigm™ MZ100 have high radiopacity values that will help with easy detection on radiographs.
Bond Strength of Different Cements to a Resin-Nano-Ceramic CAD/CAM Material

L. LAXE¹, R.H. MARCHIORI¹, M.F. DE GOES² and C.E. SABROSA¹, ¹University of the State of Rio de Janeiro, Rio de Janeiro, Brazil, ²UNICAMP, Piracicaba, Brazil

Objectives: Lava™ Ultimate Restorative (3M ESPE, Saint Paul, MN, USA) is a resin-nano ceramic CAD/CAM material used to fabricate permanent restorations for teeth and implants chairside. The objective of this study was to compare the shear bond strength of group 1) resin-modified glass ionomer cement (RelyX™ Luting Plus Automix Resin Modified Glass Ionomer Cement; 3M ESPE), group 2) self-adhesive resin cement (RelyX™ Unicem Automix 2 Self-Adhesive Resin Cement; 3M ESPE) and group 3) conventional resin cement (RelyX™ Ultimate Automix Adhesive Resin Cement; 3M ESPE) to a resin-nano ceramic CAD/CAM material.

Methods: Five slabs, measuring 15 x 10 x 1.5mm, were made of A2-HT blocks. Resin cement plugs measuring 2.3mm in diameter and 5mm in height were made with a jig (Ultradent, South Jordan, UT, USA). The cement was injected into the jig with an automix tip and polymerized for 20 seconds with an LED polymerization unit (Elipar™ S10 LED Curing Light; 3M ESPE). Prior to dispensing the conventional resin cement a self-etch adhesive (Scotchbond™ Universal Adhesive; 3M ESPE) was applied to the specimen. Specimens were stored in deionized water (37°C, 24 hours). After storage, shear bond test was performed in a universal testing machine (5566A, Instron) with a 1-kN cell, at 0.5mm/minute cross-head speed and a half-moon shear apparatus. Results were analyzed by ANOVA followed by Tukey HSD test (α=0.05).

Results: Means and standard deviations of shear bond strength values (MPa) were: (1) 0.77 ± 0.20; (2) 7.03 ± 1.59 and (3) 11.27 ± 2.33. Shear bond strength values were statistically significant different. The highest shear bond strength was achieved when using conventional resin cement in association with a self-etch adhesive. Failures for group 1 were adhesive, whereas for groups 2 and 3 where cohesive within the resin-nano ceramic material.

Conclusions: Within the limitations of this study, it was concluded that the shear bond strength of RelyX™ Ultimate Automix Adhesive Resin Cement in association with Scotchbond™ Universal Adhesive is greater than the bond strength of RelyX™ Unicem Automix 2 Self-Adhesive Resin Cement and RelyX™ Luting Plus Automix Resin Modified Glass Ionomer Cement.

3M ESPE Summary

Aim of Study: To compare shear bond strengths to Lava™ Ultimate Restorative with different cements. i.e. RelyX™ Luting Plus Automix Resin Modified Glass Ionomer Cement, RelyX™ Unicem Automix 2 Self-Adhesive Resin Cement and RelyX™ Ultimate Automix Adhesive Resin Cement.

Summary of Results: For bonding to Lava™ Ultimate Restorative, the highest shear bond strength was obtained with RelyX™ Ultimate Automix Adhesive Resin Cement and Scotchbond™ Universal Adhesive.
Lava™ Ultimate Restorative

Impact Fracture Behavior of a New Resin Nanoceramic for CAD/CAM


Objectives: Determine impact fracture resistance, flexural strength (FS) and modulus (FM) and fracture toughness (Klc) of a new Resin Nanoceramic material, compared with feldspathic porcelain and “hybrid ceramic” materials.

Methods: 1.5mm thick tiles were subjected to a single impact load via a 6.33mm diameter stainless steel sphere on a rod attached to a crosshead that slides down two guides, dropped from 3.2cm height; survival or failure was recorded, along with failure mode. Weight of rod and crosshead was 160g, yielding impact energy of 50mJ. The tile was supported by a small ring 8.5mm outer diameter, which served to concentrate the impact load. Three-point FS, FM and single-edge V-notched beam (SEVNB) Klc were measured per ISO-6872, modified to accommodate bar sizes obtainable from commercially available blocks. FS & FM: polished 1 x 4 x 14mm bars, three-point fixture, 10mm span, crosshead speed 1.0mm/minute. Klc: 3 x 4 x 14mm bars with V-notch, same 3-point fixture, 0.5mm/minute. Modulus of resilience (MR) was calculated from MR=FS²/2FM. Impact survival data were analyzed via pairwise Chi-Square tests (p<0.05) and other data via ANOVA with Tukey’s t-test (p<0.05).

Results: Table shows results and groups that are statistically not different (SND).

<table>
<thead>
<tr>
<th>Material</th>
<th># Survived Impact</th>
<th>% Impact Survival</th>
<th>n</th>
<th>SND Groups</th>
<th>Flexural Strength, MPa (StDev)</th>
<th>n</th>
<th>SND Groups</th>
<th>Flexural Modulus, MPa (StDev)</th>
<th>n</th>
<th>SND Groups</th>
<th>Modulus of Resilience, MPa (StDev)</th>
<th>n</th>
<th>SND Groups</th>
<th>Fracture Toughness Mpa-m⁰.⁵ (StDev)</th>
<th>n</th>
<th>SND Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>LVU</td>
<td>21</td>
<td>70%</td>
<td>30</td>
<td>A</td>
<td>207 (22)</td>
<td>30</td>
<td>A</td>
<td>14239 (578)</td>
<td>C</td>
<td>3.04 (0.63)</td>
<td>A</td>
<td>2.18 (0.07)</td>
<td>12</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VEN</td>
<td>0</td>
<td>0%</td>
<td>30</td>
<td>B</td>
<td>145 (13)</td>
<td>30</td>
<td>B</td>
<td>28093 (1371)</td>
<td>B</td>
<td>0.75 (0.12)</td>
<td>B</td>
<td>1.66 (0.13)</td>
<td>12</td>
<td>B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VM2</td>
<td>0</td>
<td>0%</td>
<td>30</td>
<td>B</td>
<td>102 (11)</td>
<td>30</td>
<td>C</td>
<td>48248 (4747)</td>
<td>A</td>
<td>0.21 (0.03)</td>
<td>C</td>
<td>1.43 (0.12)</td>
<td>13</td>
<td>C</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Conclusions: At the impact energy tested, LVU displayed statistically significantly superior impact fracture resistance than VM2 and VEN, while VM2 and VEN were statistically not different. FS and Klc of LVU are statistically significantly higher than VEN and VM2. The combination of high strength and lower modulus give LVU a statistically significantly higher MR than VEN and VM2. LVU can absorb significantly more stress than other materials without suffering permanent deformation or failure. The high strength and toughness of LVU helps support its use in demanding single-unit restorations, including posterior crowns and implant crowns. High fracture resistance may provide additional protection against sudden impact loads, such as from accidents or other trauma.

3M ESPE Summary

Aim of Study: Determine impact fracture resistance, flexural strength (FS), flexural modulus (FM), and fracture toughness (Klc) of Lava™ Ultimate Restorative compared with feldspathic porcelain and “hybrid ceramic” materials.

Summary of Results: Lava™ Ultimate Restorative displayed statistically significantly higher flexural strength (FS), fracture toughness (Klc), modulus of resilience (MR), and superior impact fracture resistance than feldspathic porcelain and other hybrid ceramic materials.
Lava™ Ultimate Restorative

Microstructure and Properties of Resin Hybrid CAD/CAM Materials


Objectives: Compare the microstructure, strength and hardness of resin hybrid CAD/CAM materials (see table). VE has an interpenetrating network composite structure of feldspathic porcelain and polymer; LVU has nanoceramic particles (zirconia, silica and zirconia-silica) reinforcing a polymer matrix.

Methods: Tiles were cut to 1mm thickness, polished and imaged via SEM at seven different locations. Phase content was measured with Olympus™ StreamEssentials™ Image Analysis software using the “count & measure” tool and gray scale feature selection. 4mm diameter by 8mm long specimens were conditioned in deionized water at 37°C for 24 hours prior to measuring compressive strength (CS) on an Instron™ machine. Vickers hardness (Hv) was measured according to ASTM C1327-08 on mounted & polished specimens (n=10 indents). Data were analyzed via ANOVA with Tukey’s t-test (p<0.05).

Results: The table shows results and groups that are statistically not different (SND). Volume fraction ceramic and also volume percent polymer were statistically not different in VE and LVU. CS of LVU was statistically higher than VE: Hv of VE was statistically higher than LVU.

Conclusions: Despite the similar ceramic/polymer content of LVU and VE, there are differences in strength and hardness, which might be attributed instead to differences in composition and microstructure. In resin hybrid materials, the volume content ceramic might correlate to some properties, but others also depend on microstructure and composition.

3M ESPE Summary

Aim of Study: Compare the microstructure, strength and hardness of resin hybrid ceramic CAD/CAM materials.

Summary of Results: While Lava™ Ultimate Restorative has similar ceramic/polymer content as Vita Enamic, there are differences in compressive strength and hardness which might be attributed to differences in composition and microstructure of the materials.
Impact of Fast Sintering on Material Properties of Translucent Zirconia

A. HERRMANN¹, R. DITTMANN¹, G. SCHECHNER¹, H. HAUPTMANN¹, E. POPP², J. ROLF³ and V.A. RUSSELL³, ¹3M ESPE Dental Products, Seefeld, Germany, ²3M Deutschland GmbH, Seefeld, Germany, ³3M ESPE Dental Products, Saint Paul, MN

Objectives: Short sintering cycles enable high productivity and flexibility during processing zirconia dental restorations. In this study clinically relevant properties of a translucent zirconia material processed with standard sintering cycle and fast sintering cycle have been compared.

Methods: A translucent zirconia material (Lava™ Plus High Translucency Zirconia, 3M ESPE) was sintered (Lava™ Furnace 200) with standard sintering protocol 1450°C for two hours dwell time and a faster sintering cycle at 1500°C for 30 minutes dwell time. Biaxial fracture strength, contrast ratio and color match were analyzed for both sintering cycles. Initial strength was determined according ISO 6872 in a punch-on-three-balls test mode (discs thickness 1.2mm, diameter 14mm) for n=30 each group. Contrast ratio respectively opacity was investigated on 1.0mm polished discs (n=6) with spectrophotometer (Color i7, X-Rite) in remission mode. Color match was investigated visually with three different operators at five different shaded (Lava™ Plus Dying Liquids) standardized anterior crowns (n=3) and compared to each other in a light cabinet (D65, Spectralight III, X-Rite). Data were analyzed with one-way ANOVA and Tukey’s t-test (p<0.05).

Results: Total sintering time, mean fracture strength, contrast ratio and color match results are summarized in following table.

<table>
<thead>
<tr>
<th></th>
<th>Standard Sintering Cycle</th>
<th>Speed Sintering Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sintering Time Without Cooling (minutes)</td>
<td>225</td>
<td>90</td>
</tr>
<tr>
<td>Mean Fracture Strength (MPa)</td>
<td>1160 ± 159</td>
<td>1127 ± 135</td>
</tr>
<tr>
<td>Contrast Ratio (%)</td>
<td>66.4 ± 0.3</td>
<td>66.6 ± 0.1</td>
</tr>
<tr>
<td>Color Match</td>
<td>No Visible Difference</td>
<td>No Visible Difference</td>
</tr>
</tbody>
</table>

Conclusions: The speed sintering cycle allows a time reduction of more than two hours compared to the standard sintering cycle. No statistical significant difference in fracture strength, contrast ratio and color match was observed between groups sintered with standard and speed sintering cycle. The investigated speed sintering cycle has no impact on clinical relevant material properties of Lava™ Plus High Translucency Zirconia.

3M ESPE Summary

Aim of Study: To investigate a shorter cycle time firing schedule for Lava™ Plus High Translucency Zirconia.

Summary of Results: The sintering time required for Lava™ Plus High Translucency Zirconia can be reduced by more than two hours by increasing the sintering temperature by 50°C without impacting optical or mechanical properties.
Economic Analysis of Mandibular Overdentures Retained by Dental Mini Implants

M.P. DELLA VECCHIA, T.R. CUNHA, A.B. RIBEIRO, D.B. SORGINI, V.A. MUGLIA, A.C. DOS REIS and R.F. DE SOUZA, Ribeirão Preto Dental School — University of São Paulo, Ribeirão Preto, Brazil

Objectives: The aim of this study was to quantify treatment costs of mandibular overdentures retained by mini implants or conventional implants by means of a randomized clinical trial.

Methods: Fifty eight edentulous patients received either one of three possible interventions at the anterior mandible: (G1) four mini implants (MDL 2.0mm, Intra-Lock System, São Paulo, Brazil); (G2) two mini implants; and (G3) two conventional implants (Morse-Lock Straight 4.0mm, Intra-Lock System), as a comparator. Direct costs of surgical and post surgical procedures were calculated for the operator and the dental assistant. Comparisons between groups were conducted by means of the Anova/Tukey HSD ($\alpha=0.05$).

Results: The insertion of the implants demanded from the operator median time periods of 35.6 (12.26) minute, 22.9 (12.57) minute and 38.1 (16.55) minute for groups (G1), (G2) and (G3) respectively; and significantly lower for G2. The post surgical procedures demanded from the operator median time periods of 36.9 (8.47) minute, 37.7 (14.55) minute and 34.4 (17.31) minute for the same groups without significant difference. The time spent by the dental assistant did not differ between groups, with median time periods of 35.9 to 40.4 minutes (surgical procedures) and 8.7 to 8.9 minutes (post surgical procedures).

Conclusions: Within the limitations of this study, it can be concluded that after 36 months the direct technique can be viable when using bisacrylic composites. One crown of each material fractured. Protemp™ 4 Temporization Material performed better with regard to wear, maintenance of surface luster as well as maintenance of gingival health. (This study was partially supported by 3M ESPE, Seefeld, Germany).

It can be concluded that the insertion of mini implants is faster than two conventional implants, i.e., 60% of operator’s time, although the post surgical time does not depend on number and implant types.

3M ESPE Summary

Aim of Study: The aim of this study was to quantify treatment costs of mandibular overdentures retained by mini implants or conventional implants by means of a randomized clinical trial.

Summary of Results: It can be concluded that the insertion of mini implants is faster than two conventional implants, i.e., 60% of operator’s time, although the post surgical time does not depend on number and implant types.
Objectives: To test and validate a customized SmartPeg for primary stability assessment of 3M™ ESPE™ MDI Mini Dental Implant in a rabbit model.

Methods: One-piece narrow diameter implants (NDIs) have been recommended for overdenture treatment of edentulous jaws with reduced mesiodistal space or reduced ridge width (ITI consensus 2013). Since NDIs can be immediately loaded, it is important to carry out stability testing. Although primary implant stability assessment using resonance frequency analysis is currently available for conventional implants, the existing SmartPegs do not fit on single unit NDIs. Therefore, we developed and validated a customized SmartPeg for these implants to measure Implant Stability Quotient (ISQ).

Eight New Zealand white rabbits were used for the study. The protocol was approved by the McGill Animal Ethics Review Board. Sixteen 3M™ ESPE™ MDI Mini Dental Implant and sixteen standard implants (Ankylos®, Dentsply) were inserted into the tibia/femur of the rabbits. Each rabbit randomly received two 3M™ ESPE™ MDI Mini Dental Implant and two Ankylos® implants. ISQ values were measured with the help of an Osstell®ISQ device using custom made SmartPegs for the MDIs and implant specific SmartPegs™ (Osstell®) for the Ankylos® implants. Measurements were obtained both immediately following implant placement surgery and after a six-week healing period. Each reading was taken thrice and their average compared using Wilcoxon sign-rank tests.

Results: The ISQ values for both implant types at both time periods were consistent: 3M™ ESPE™ MDI Mini Dental Implant insertion, median 53.3, range 8.3; six weeks median 60.5, range 5.5; Ankylos®-insertion, median 58.5, range 4.75; six weeks median 65.5, range 9.3. These values indicate that both types of implants achieved primary and secondary stability. These data were also validated by previously reported histological data (Dhaliwal et al, 2012). ISQ values of both 3M™ ESPE™ MDI Mini Dental Implant and Ankylos® increased significantly from the time of insertion to six-weeks post-insertion (p<0.05).

Conclusions: Valid ISQ measurement of 3M™ ESPE™ MDI Mini Dental Implant is possible with the help of a custom made SmartPeg.

3M ESPE Summary

Aim of Study: To test and validate a customized SmartPeg for primary stability assessment of 3M™ ESPE™ MDI Mini Dental Implant in a rabbit model.

Summary of Results: Valid ISQ measurement of 3M™ ESPE™ MDI Mini Dental Implant is possible with the help of a custom made SmartPeg.
Indirect Restorative References

Lava™ Ultimate Restorative and Lava™ Plus High Translucency Zirconia

AADR 2014  Abstract #169
Adhesion to Saliva Contaminated Zirconia Cleaned with Different Methods
C. THALACKER, G. RAIA, R. HECHT, S. HADER and D. KRUEGER, 3M Deutschland GmbH, Seefeld, Germany, 3M ESPE, Saint Paul, MN

AADR 2014  Abstract #793
Influence of Cooling Rate on Residual Stresses in Zirconia-Porcelain Bilayers
M.N. KARWAA, M.N. JANAL, M.S. WOLFF and Y. ZHANG, New York University, New York, NY

AADR 2014  Abstract #796
A New Class of Zirconia Material for Dental Application

AADR 2014  Abstract #862
Stress Distribution at the Interface of Restorative Materials and Cements
G.L.P. MIRANDA, C.N.B. PEREIRA, A.H.F. AVELAR, A.G.P. ANDRADE, R.R. SILVEIRA and N.R.F.A. SILVA, Restorative Dentistry Universidade Federal de Minas Gerais, BELO HORIZONTE, Brazil, Universidade Federal de Minas Gerais, Belo Horizonte, Brazil, Engineering Mechanics Universidade Federal de Minas Gerais, BELO HORIZONTE, Brazil, Laboratory of Sport Biomechanics Universidade Federal de Minas Gerais, BELO HORIZONTE, Brazil

AADR 2014  Abstract #1346
Marginal and Internal Fit of Zirconia Crown and Four-Unit Bridge
K. CHARUKIETKAJORN, P. SINAWARAT and C. ANUNMANA, Mahidol university, Bangkok, Thailand, Mahidol University, Bangkok, Thailand

AADR 2014  Abstract #1447
Effects of Grain Size and Transformation in Partially Stabilized Zirconia
T.J. LUCAS, G.M. JANOWSKI, D. CAKIR-USTUN and J. BURGESS, School of Dentistry, University of Alabama at Birmingham, Birmingham, AL, University of Alabama, Birmingham, AL

AADR 2014  Abstract #1454
Flexural Strength of Y-TZP Ceramic After Grinding and Heat Treatment

continued on next page >
Indirect Restorative References

Lava™ Ultimate Restorative and Lava™ Plus High Translucency Zirconia (cont.)

IADR

IADR 2014  Abstract #11
Do Surface-Treated Dental Zirconia Ceramics Degrade?
M. INOKOSHI¹, K. VANMEENSEL², F. ZHANG³, S. MINAKUCHI⁴, J. DE MUNCK⁵, J. VLEUGELS⁶, I. NAERT⁷ and B. VAN MEERBEEK⁸, ¹KU Leuven BIOMAT, Department of Oral Health Sciences, KU Leuven (University of Leuven) & Dentistry, University Hospitals Leuven, Leuven, Belgium, ²Department of Metallurgy and Materials Engineering (MTM), KU Leuven (University of Leuven), Heverlee (Leuven), Belgium, ³Tokyo Medical & Dental University, Tokyo, Japan

IADR 2014  Abstract #82
A Constitutive Relationship for Sliding-contact Fracture of Dental Ceramics
Y. ZHANG and L. REN, New York University, New York, NY

IADR 2014  Abstract #300
Effect of Grinding/Resintering on the Fatigue Limit of Lava™ Y-TZP
J.M.D.S.N. REIS¹, G.S. POLLI¹, G.R. HATANAKA¹, F.O. ABI-RACHED², R.G. FONSECA² and L.A.P. PINELLI¹, ¹UNESP — Univ Estadual Paulista, Araraquara Dental School, Araraquara, Brazil, ²UNESP — Univ Estadual Paulista, Araraquara Dental School, Araraquara - São Paulo, Brazil

CED

IADR 2013 CED  Abstract #393
Roughening of Zirconia with Nanosecond Nd:YAG Laser: A Pilot Study
T. SARI, Department of Prosthodontics, Bezmialem Vakif University Faculty of Dentistry, Istanbul, Turkey, S. UNAL, Prosthodontics, Dicle Universitesi, Diyarbakir, Turkey, E. TALAY, Prosthodontics, Selcuk Universitesi, Konya, Turkey, I. YONDEM, Campus-Konya, Selcuk University, Konya, Turkey and A. USUMEZ, Department of Prosthodontics, Bezmialem Vakif University Faculty of Dentistry, Yıstandıbul, Turkey

Lava™ Ultimate Restorative

AADR

AADR 2014  Abstract #98
Clinical Evaluation of CAD/CAM Nano-Ceramic and Leucite-Reinforced Crowns
D.J. FASBINDER, G.F. NEIVA, J.B. DENNISON, D. HEYS and R. HEYS, University of Michigan, Ann Arbor, MI

AADR 2014  Abstract #167
Interfacial Fracture Toughness of Adhesive Resin Cement — Lithium-Disilicate/Resin-Composite Blocks
S. MESMAR and N.D. RUSE, University of British Columbia, Vancouver, BC, Canada

continued on next page >
Lava™ Ultimate Restorative (cont.)

AADR 2014  Abstract #253
Wear and Mechanical Properties of CAD/CAM Resin Materials
K. TSUBOTA1, K. SHIRATSUCHI1, T. FURUICHI1, T. TAKAMIZAWA1, M. MIYAZAKI1 and M.A. LATTA2, 1Nihon University, School of Dentistry, Tokyo, Japan, 2Creighton University, Omaha, NE

AADR 2014  Abstract #710
A Universal Function for the Edge Chip Resistance of Materials
G.D. QUINN1, A. GIUSEPPETTI2 and J.B. QUINN1, 1ADAF Paffenbarger Research Center, Gaithersburg, MD, 2ADAF Paffenbarger Research Center, Gaithersburg, MD

AADR 2014  Abstract #714
Mechanical Properties of New Chairside CAD/CAM Materials
A. AWADA and D. NATHANSON, Boston University Henry M. Goldman School of Dental Medicine, Boston, MA

AADR 2014  Abstract #864
Bond Durability of Self-Adhesive Resin Cements to CAD/CAM Restorative Materials
S. FUKUSHIMA1, R. AKATSUKA1 and K. SASAKI2, 1Tohoku University, Sendai, Japan, 2Tohoku University - Graduate School of Dentistry, Sendai, Japan

AADR 2014  Abstract #1165
Dimensional Stability of a Resin Nano-Ceramic CAD/CAM Restorative Material
A. ROYAL, R. KRAMER and J.C. MITCHELL, College of Dental Medicine, Midwestern University, Glendale, AZ

AADR 2014  Abstract #1448
Staining of Four Dental CAD/CAM Restorative Materials Over Time
T.J. HILL and G. TYSOWSKY, Ivoclar Vivadent, Inc, Amherst, NY

IADR
IADR 2014  Abstract #151
Characterization of Nanoceramic Resin Composite and Lithiumdisilicate Blocks for CAD/CAM
I. THORNTON and N.D. RUSE, University of British Columbia, Vancouver, BC, Canada

IADR 2014  Abstract #269
Stress Analysis of Endocrown-Restoration Prepared from Different Materials on A-Maxillary-Central-Incisor
B. BECERIKLI1, M.A. MALKOC2, O. ERASLAN3, E. CAL1 and G. ESKITASCIOGLU4, 1Ege University, Izmir, Turkey, 2Inonu University, Malatya, Turkey, 3Selcuk University, Konya, Turkey, 4Yuzuncuyl University, Van, Turkey

IADR 2014  Abstract #1464
Effect of Surface Treatment on the Bonding CAD/CAM Composite Restoration
K. CHOI, Kyung Hee University, Seoul, South Korea and J. YEOM
Fluoride Varnish Carrier Constituents Effect on In Vivo Fluoride Release

D. DOWNEY¹, J.B. DENNISON², P. YAMAN³, G.F. NEIVA³, G.J. ECKERT⁴ and C. GONZALEZ-CABEZAS³¹US Navy, Parris Island, SC, ²University of Michigan, Plymouth, MI, ³University of Michigan, Ann Arbor, MI, ⁴Indiana University School of Medicine, Indianapolis, IN

Objectives: To compare the in vivo release of fluoride into unstimulated whole saliva after the application of three different 5% NaF varnishes.

Methods: Each subject (n=15) had approximately 0.275mL of a 5% NaF varnish. Either Enamel Pro (EP), Vanish™ 5% Sodium Fluoride (V), Duraphat (D), or a placebo with no fluoride (P) was applied to the buccal surfaces of all erupted teeth. Subjects received varnish applications in random order with a two week wash out period between treatments. Following each varnish application, unstimulated whole saliva was collected at baseline, 1, 4, 6, 26 and 50 hours. Samples were centrifuged and supernatant fluoride concentration was determined using a fluoride ion specific electrode. Mixed linear effects models were used to evaluate the effects of varnish and time on salivary fluoride concentration to a 5% significance level.

Results: For time periods 1, 4, 6 and 26 hours, treatment with Duraphat and Vanish™ 5% Sodium Fluoride resulted in a significantly higher mean concentration of salivary fluoride. Fluoride release from Enamel Pro returned to baseline (<0.05ppm) at 26 hours, while Duraphat and Vanish™ 5% Sodium Fluoride did not return until 50 hours. For all three varnishes, the maximum amount of fluoride was measured at one hour; D (18.94 ± 9.95ppm), V (19.78 ± 14.57ppm), EP (6.19 ± 4.00ppm) and the fluoride concentration decreased at each measurement interval thereafter.

Conclusions: Despite the similar fluoride concentrations, the fluoride release into saliva from these varnishes over time differs. Treatment with Duraphat and Vanish™ 5% Sodium Fluoride resulted in significantly higher fluoride levels in the supernatant of unstimulated saliva over 26 hours.

3M ESPE Summary

Aim of Study: To evaluate in vivo the fluoride release of Vanish™ 5% Sodium Fluoride in comparison with two different 5% sodium fluoride varnishes and a control group over 50 hours into the unstimulated whole saliva.

Summary of Results: Vanish™ 5% Sodium Fluoride and Duraphat showed a significantly higher mean concentration of salivary fluoride and did not return to baseline until 50 hours.
New Air-Polishing Powder

Novel Air-Polishing Powder: Surface Roughness Changes of Composite Materials

R. GUGGENBERGER1, I. HAEBERLEIN2, A. SAFI3 and B. SCHMID2, 13M Deutschland GmbH, Seefeld, Germany, 23M ESPE Dental Products, Seefeld, Germany

A newly developed glycine based air-polishing powder, functionalized by tri-calcium phosphate, allows gentle professional tooth cleaning including the potential for hypersensitivity pain relief by immediate occlusion of accessible dentinal tubules.

Objectives: Evaluation of the effect of an experimental TCP-functionalized air-polishing powder on the surface quality of composites in comparison to other air-polishing powders and prophy pastes.

Methods: Experimental Powder (EP), 3M ESPE, Clinpro™ Prophy Powder (CPP), 3M ESPE; Cavitron Prophy-Jet® Powder (CPJ), Dentsply, were applied with a Cavitron Prophy-Jet® (Dentsply) air polishing device. Prophy pastes Enamel Pro® Fine/Coarse (Premier) and Cleanic® Prophy Paste (Kerr) were applied with a MED Dental Filling Unit (W&H) at 4,000 rpm. All treatments occurred for five seconds on composite samples Filtek™ Z250 Restorative, Filtek™ Supreme XTE Restorative (3M ESPE), Tetric Evo Ceram® (Ivoclar Vivadent), Esthet X® HD (Dentsply), which were prepared and light-cured according to manufacturer’s instructions. Surface roughness changes on composite surfaces were measured by Perthometer S2 (Mahr); (n=9).

Results: Surface roughness changes Ra (µm):

<table>
<thead>
<tr>
<th>Materials/Treatment</th>
<th>Filtek™ XTE Restorative</th>
<th>Filtek™ Z250 Restorative</th>
<th>EsthetX</th>
<th>Tetric EvoCeram</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated</td>
<td>0.082 ± 0.007</td>
<td>0.059 ± 0.007</td>
<td>0.100 ± 0.013</td>
<td>0.112 ± 0.036</td>
</tr>
<tr>
<td>CPP</td>
<td>0.091 ± 0.011&lt;sup&gt;C&lt;/sup&gt;</td>
<td>0.233 ± 0.043&lt;sup&gt;C&lt;/sup&gt;</td>
<td>0.326 ± 0.110&lt;sup&gt;B&lt;/sup&gt;</td>
<td>0.359 ± 0.035&lt;sup&gt;C&lt;/sup&gt;</td>
</tr>
<tr>
<td>EP</td>
<td>0.209 ± 0.012&lt;sup&gt;B,C&lt;/sup&gt;</td>
<td>0.349 ± 0.014&lt;sup&gt;BC&lt;/sup&gt;</td>
<td>0.272 ± 0.046&lt;sup&gt;A&lt;/sup&gt;</td>
<td>0.502 ± 0.009&lt;sup&gt;C&lt;/sup&gt;</td>
</tr>
<tr>
<td>Cavitron</td>
<td>0.624 ± 0.125&lt;sup&gt;A&lt;/sup&gt;</td>
<td>0.520 ± 0.059&lt;sup&gt;A&lt;/sup&gt;</td>
<td>0.715 ± 0.092&lt;sup&gt;A&lt;/sup&gt;</td>
<td>1.044 ± 0.094&lt;sup&gt;A&lt;/sup&gt;</td>
</tr>
<tr>
<td>Cleanic</td>
<td>0.350 ± 0.078&lt;sup&gt;B&lt;/sup&gt;</td>
<td>0.476 ± 0.056&lt;sup&gt;B&lt;/sup&gt;</td>
<td>0.341 ± 0.008&lt;sup&gt;B&lt;/sup&gt;</td>
<td>0.644 ± 0.069&lt;sup&gt;BC&lt;/sup&gt;</td>
</tr>
<tr>
<td>Enamel Pro, Coarse</td>
<td>0.724 ± 0.293&lt;sup&gt;A&lt;/sup&gt;</td>
<td>0.621 ± 0.069&lt;sup&gt;A&lt;/sup&gt;</td>
<td>0.326 ± 0.001&lt;sup&gt;B&lt;/sup&gt;</td>
<td>0.906 ± 0.223&lt;sup&gt;AB&lt;/sup&gt;</td>
</tr>
<tr>
<td>Enamel Pro, Fine</td>
<td>0.350 ± 0.072&lt;sup&gt;B&lt;/sup&gt;</td>
<td>0.522 ± 0.188&lt;sup&gt;A&lt;/sup&gt;</td>
<td>0.337 ± 0.030&lt;sup&gt;B&lt;/sup&gt;</td>
<td>0.599 ± 0.217&lt;sup&gt;C&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Values with different superscript characters are statistically different (One-way ANOVA, p<0.05). No statistically significant difference was observed between the surface roughness increase in response to CPP and EP treatment.

Conclusions: The novel experimental powder for supra/sub-gingival tooth cleaning and dentinal hypersensitivity treatment showed equivalent surfaces quality on composite materials as commonly used prophy-pastes, while a classic, bi-carbonate based air-polishing powder showed significantly higher surface roughness.

3M ESPE Summary

Aim of Study: To evaluate the surface quality of composite materials after cleaning with a new developed TCP-functionalized air-polishing powder in comparison to other air-polishing powders and prophy pastes.

Summary of Results: The new TCP-FA/glycine based air-polishing powder showed no statistically significant differences in surface roughness on composite materials in comparison to 3M™ ESPE™ Clinpro™ Prophy Powder and commonly used prophy pastes. Whereas a bi-carbonate air-polishing powder affected the quality of the composite material due to a significantly increase of the surface roughness.
The Effect of Resin Modified Glass Ionomer Varnish on Exposed Dentine
A. MIELCZAREK, Conservative Dentistry, Medical University of Warsaw, Warsaw, Poland

Dentine hypersensitivity is caused by fluid movement within the exposed dentin tubules. The main strategy of hypersensitivity treatment is based on application of desensitizing agents for occluding the dentin tubules.

Objectives: The aim of this study was to evaluate the effectiveness of resin modified glass ionomer varnish and conventional sodium fluoride containing varnish on dentin tubules occlusion.

Methods: Forty-five human dentin specimens were embedded with an acrylic resin, ground and etched to open the dentin tubules. One half of each sample was covered by nail varnish and safe as a baseline control. Specimens were randomly assigned to two experimental and one control groups (n=15), according to the dentin surface treatments: Group VXT- Vanish™ XT Extended Contact Varnish application (3M ESPE), Group D- Duraphat varnish application (Colgate) and Group P- placebo (distilled water). Dentine surface structure and composition at baseline and after treatment was characterized quantitatively and qualitatively by SEM and EDS analysis. One-way ANOVA test was used for the statistical analysis.

Results: The results of the study demonstrated that resin modified glass ionomer varnish was more effective in dentin tubules occlusion than conventional one. The percent of occluded dentin was significantly higher in VXT as compared to D and P Group (p<0.01). EDX revealed similar dentin composition in VXT and D Groups, with high peaks of Ca and P in post treatment analysis.

Conclusions: Vanish™ XT Extended Contact Varnish application can be effective in dentin hypersensitivity treatment. Further research is required to confirm the long lasting efficacy of this formulation under clinical conditions.

3M ESPE Summary

Aim of Study: To evaluate the effectiveness of Vanish™ XT Extended Contact Varnish on dentin tubules occlusion in comparison to a conventional sodium fluoride varnish and placebo.

Summary of Results: It can be shown that Vanish™ XT Extended Contact Varnish was significant higher effective in occluding dentin tubules than the conventional varnish.
Vanish™ 5% Sodium Fluoride White Varnish

Fluoride-Varnish Efficacy on In Situ Remineralization of Enamel Caries-Like Lesions

A.T. HARA1, F. LIPPERT2, E.A. MARTINEZ-MIER1, G.J. ECKERT3 and D. ZERO1, 1Indiana University School of Dentistry, Indianapolis, IN, 2Indiana University, Indianapolis, IN, 3Indiana University School of Medicine, Indianapolis, IN

Objectives: In vitro studies have shown that fluoride varnishes (FV) differ significantly in their ability to remineralize and fluoridate enamel caries lesions, as respectively measured by surface microhardness recovery (%SMR) and enamel fluoride uptake (EFU). We hypothesized that similar results could be observed in situ.

Methods: This study was approved by the local IRB and followed a five-leg in situ cross-over design. In each leg, 28 subjects wore their mandibular partial denture 24 hours/one day with two previously demineralized (0.05M lactic acid, 0.2% Carbopol solution, 50% saturated with respect to hydroxyapatite, pH 5.0, 24 hours) enamel slabs were treated with one of the following FV: A-Vanish™ 5% Sodium Fluoride (3M ESPE) (high %SMR, low EFU; based on our previous in vitro data), B-Flor-Opal (Ultradent) (low %SMR, high EFU), C-Enamel-Pro (Premier) (high %SMR, high EFU), D-Prevident (Colgate) (clinical reference, replacing Duraphat) or E-Negative control (no varnish). After three days, subjects returned to the study site and specimens were wrapped in gauze, to allow plaque accumulation on enamel. Toothbrushing of natural teeth was performed twice/day with F-free toothpaste. After 14 days, enamel specimens were collected and analyzed for %SMR and EFU. Data were analyzed by ANOVA models suitable for cross-over, at 5% significance level.

Results: A had significantly higher %SMR than all other treatments; B, C, D did not differ from each other and had significantly higher %SMR than the control. EFU was significantly lower for the control than for all other treatments; B had significantly lower EFU than A and D. Neither %SMR nor EFU in vitro data were able to predict in situ results, although better approximation was observed for %SMR.

Conclusions: All tested FV were able to remineralize enamel; however, they presented different efficacies. Comparative clinical trials are warranted to confirm these results. Adequate in vitro tests are necessary to predict the in situ efficacy of FV.

3M ESPE Summary

Aim of Study: To confirm the results of the former in vitro studies in an in situ model that fluoride varnishes differ significantly in their ability to remineralize and fluoridate enamel caries lesions. The surface micro hardness recovery and enamel fluoride uptake of Vanish™ 5% Sodium Fluoride have been compared to three fluoride varnishes and a negative control group.

Summary of Results: Vanish™ 5% Sodium Fluoride showed a significantly higher % of surface micro hardness than the other tested fluoride varnishes. Flor-Opal has significantly lower Fluoride uptake than Vanish™ 5% Sodium Fluoride and Prevident.
Clinpro™ 5000 1.1% Sodium Fluoride Anti-Cavity Toothpaste

20-Day Incipient Lesion Remineralization with 5000 ppm-Fluoride Dentifrice

P. KLAIBER and P. FLANIGAN, 3M ESPE Dental Products Laboratory, Saint Paul, MN

Objectives: Compare surface-microhardness and F-uptake from incipient lesions in enamel using two dentifrices containing fluoride-(F) and tri-calcium phosphate-(TCP) in an in vitro pH-cycling model.

Methods: Bovine enamel specimens were cut into 4.5mm square pieces. Each specimen was cast in an acrylic resin block, ground, polished, rinsed and stored in a hydrated environment. Specimens were immersed into pH4.9 Carbopol demineralization solution and stored 96 hours at 37°C to establish lesions. After demineralization, Vickers indentations were made on each specimen (4x 200g load, 15 seconds, averaged) and specimens were placed into stratified treatment groups (n=10) so average initial surface microhardness (VHN) of the groups were statistically not different. Dentifrices Clinpro™ 5000 1.1% Sodium Fluoride Anti-Cavity Toothpaste-(A), Colgate® PreviDent® BoosterPlus-(B), as well as an artificial saliva control-(C) were evaluated using daily pH cycling (four one-minute treatments and one four-hour acid challenge per day) for 10 and 20 days. Post cycling, the specimens were subjected to Vickers surface microhardness (200g force, 15 second dwell) and biopsied (100µm deep x 1mm diameter) with a microdrill to determine enamel-fluoride-uptake-(EFU). A final 24 hour acid challenge was done by exposing the samples to demineralization solution. Fluoride uptake and surface-microhardness values were compared using one-way ANOVA (p<0.05).

Results: Both VHN and EFU results showed the dentifrices exhibited a statistically significant increase at 10 and 20 days compared to the artificial saliva control. VHN results for A were numerically higher than B, but the differences were not statistically significant. Additionally, acid challenge did not diminish treatment efficacy vs. untreated samples. F taken into the teeth remained high after challenge for treatments A and B. Superscript letters denote groups that are not statistically different.

Conclusions: Based on performance in this in vitro model, it’s concluded that dentifrice A has supreme remineralization efficacy against control and analogous performance to dentifrice B. When challenged with acid, teeth treated with dentifrices A and B retained remineralization and fluoride benefits.

3M ESPE Summary

Aim of Study: To determine if high fluoride (5000 ppm) dentifrices perform similarly in a number of in vitro tests, culminating in a 10 and 20 day pH cycling model.

Summary of Results: Dentifrices containing 5000 ppm fluoride and TCP improve enamel hardness. In this study, Clinpro™ 5000 1.1% Sodium Fluoride Anti-Cavity Toothpaste and PreviDent Booster Plus performed similarly, teeth treated with each product had minimal hardness loss after a final low pH challenge.
New Air-Polishing Powder

Hypersensitivity Treatment: New Air-Polishing Powder for Occlusion of Dentinal Tubules

E.S. NEUENFELDT¹, B. SCHMID², A. SAFI² and I. HAEBERLEIN³, ¹3M ESPE, Saint Paul, MN, ²3M ESPE Dental Products, Seefeld, Germany, ³3M Deutschland GmbH, Seefeld, Germany

Objectives: The invention of glycine based air-polishing powder (Clinpro™ Prophy Powder/3M ESPE) provides an air-polishing procedure that is less messy and therefore more comfortable for the patient. The minimally abrasive properties of this powder allow for the unique indication of subgingival air-polishing. Patients complain that the water-powder-air-stream is unpleasant and causes tooth hypersensitivity. A new glycine based air-polishing powder is under development which allows gentle professional tooth cleaning with hypersensitivity pain relief by immediate occlusion of accessible dentinal tubules.

Methods: Different amounts of functionalized tri-calcium phosphate (TCP-FA) have been added to glycine-based air-polishing powder. Occlusion of dentinal tubules at human dentin samples have been measured after one second of air-polishing via permeability measurements (n=3). The EMS Handy II air-polishing device was used. 3D-Laser-Scanning-Microscopy was applied for inspection of the dentinal tubule occlusion before and after acid challenge of the treated dentin samples.

Results: Addition of TCP-FA, between 5–7.5%, to glycine-based air-polishing powder lowered dentinal permeability statistically significant (p<0.05) between 85–96% in comparison to the untreated control dentin sample. All TCP-FA/glycine powders show almost complete occlusion of the dentinal tubules (>90%) in surface 3D-Laser-Scanning-Microscopy evaluation even after acid challenge of the dentin samples. A statistically significant difference between the powders has not been observed.

Conclusions: The new TCP-FA/glycine air-polishing powder allows selective occlusion of open dentinal tubules with TCP-FA particles, although the powder contains between 92.5–95% glycine-powder particles. This unique direction of TCP-FA into the dentinal tubules is a prerequisite for hypersensitivity treatment. The TCP-FA is minimally water soluble which ensures occlusion of dentinal tubules even after acid challenge, whereas glycine is quickly water soluble. Further studies are required to evaluate the clinical efficacy of this new air-polishing powder for hypersensitivity treatment.

3M ESPE Summary

Aim of Study: To evaluate the performance of a new developed TCP-FA/glycine based air-polishing powder for professional tooth cleaning with hypersensitivity pain relief by immediate occlusion of accessible dentinal tubules.

Summary of Results: The new TCP-FA/glycine based air-polishing powder showed a statistically significant reduction of dentinal permeability in comparison to the untreated control dentin sample. The powder allows a selective occlusion of open dentinal tubules with TCP-FA particles — a prerequisite for hypersensitivity treatment.
Vanish™ XT Extended Contact Varnish

Protection of Demineralized Enamel by Resin Coating: Nano-Indentation Evaluation

E.Z. ALSAYED1, A. SADR2, S. NAKASHIMA2, I. HARIRI1, T.A. BAKHSH3, Y. SHIMADA2, J. TAGAMI2 and Y. SUMI4, 1Tokyo Medical & Dental University, Tokyo, Japan, 2Tokyo Medical and Dental University, Tokyo, Japan, 3King Abdulaziz University, Jeddah, Saudi Arabia, 4National Center for Geriatrics and Gerontology, Obu, Japan

Objectives: To investigate the potential of resin coating materials in protection of enamel against demineralization using nano-indentation.

Methods: Forty-five blocks were prepared from buccal enamel of bovine incisors (6 × 3 × 3mm) and embedded in epoxy resin. Five specimens were used as control and the rest were partially coated using a resin-based coating material in four groups (n=10/group) as follow: (1) Shield Force Plus (SFP, Tokuyama Dental), (2): Clearfill SE Protect (SEP, Kuraray Noritake Dental), (3): PRG Barrier Coat (PBC, Shofu), (4): Vanish™ XT Extended Contact Varnish (VXT, 3M ESPE). The specimens were subjected to water storage (37°C, 24 hours) and thermal stress challenge (5000 cycles, 5 and 55°C) and then exposed to demineralization for one week in an acidic solution (pH 4.5) at 37°C. The specimens were embedded, cut perpendicular to the coated surface and fine polished for nano-indentation. Hardness of enamel beneath the coat and adjacent area was measured using a Berkovich tip under 2mN load with one second hold segment, from surface up to 200µm depth.

Results: All materials showed the ability to protect enamel from demineralization and significant difference was found between protected and non-protected area (p<0.05). The unprotected area adjacent to VXT showed significantly higher hardness compared to the control and other materials. Nevertheless, acid-etched enamel beneath VXT showed lower hardness compared to the enamel protected by self-etching resins.

Conclusions: Resin-based materials applied as a coat with a few micrometer thickness to cover the enamel surface will be protected from erosive acid challenges. Coating materials actively releasing ions such as fluoride can not only protect the covered areas, but also benefit the adjacent hard tissue.

3M ESPE Summary

Aim of Study: Evaluation of resin coating materials efficiency to protect enamel against demineralization using nano-indentation method.

Summary of Results: Resin-based materials applied as a coat with a few micrometer thickness to cover the enamel surface will be protected from erosive acid challenges. Coating materials actively releasing ions such as fluoride can not only protect the covered areas, but also benefit the adjacent hard tissue.
Clinpro™ 5000 1.1% Sodium Fluoride Anti-Cavity Toothpaste

AADR

AADR 2014  Abstract #778
CPP-ACP-Fl and TCP-Fl Pastes: In Vitro Root Surface Caries
J. HICKS, Baylor College of Medicine, Houston, TX and C. FLAITZ, University of Texas at Houston, Houston, TX

Clinpro™ Tooth Créme

AADR

AADR 2014  Abstract #498
Abrasion and Stain-Removal Efficiency of a Novel Brush-On Remineralizing Agent
S. HOTTA, T. SATO, Y. ISIHARA, F. FUSEJIMA and T. KUMAGAI, GC CORPORATION, Tokyo, Japan

Peridex™ Chlorhexidine Gluconate 0.12% Oral Rinse

AADR

AADR 2014  Abstract #841
In vitro Inhibition of Bacterial Growth Using NaF and Chlorexidine
M. XIMENES¹, R. ARNOLD², L.A. PIMENTA³ and R.S. VIEIRA⁴, ¹Universidade Federal de Santa Catarina — UFSC, Florianópolis, Brazil, ²University of North Carolina, Chapel Hill, NC, ³Universidade Federal De Santa Catarina, Florianópolis — SC, Brazil, ⁴Universidade Federal de Santa Catarina, Florianópolis, Brazil

continued on next page >
Vanish™ 5% Sodium Fluoride White Varnish (Cavity Shield)

AADR
AADR 2014  Abstract # 235
Effects of Fluoride Varnish on Bond Strength of Orthodontic Brackets
R.T.L. NHAN, Louisiana State University School of Dentistry, New Orleans, LA

AADR 2014  Abstract # 775
An In Vitro Study to Determine Anti-Caries Efficacy of Fluoride Varnishes
L. AL DEHAILAN, Indiana University, Indianapolis, IN, E.A. MARTINEZ-MIER, Indiana University School of Dentistry, Indianapolis, IN and F. LIPPERT, IUPUI, Indianapolis, IN

AADR 2014  Abstract # 873
Fluoride Varnish Surface Characterization: Wettability and Chemical Composition
I.S. VIRDI1, D.L. DENG2 and R. FRANÇA2, 1Dental Biomaterials Research Laboratory, Winnipeg, MB, Canada, 2University of Manitoba, Winnipeg, MB, Canada

AADR 2014  Abstract #1209
Evaluation of Fluoride Release of Fluoride Varnishes
X. HUO, Dentsply Caulk, Milford, DE, S. PATEL, Densply Caulk, Milford, DE and T. SIMONTON, Dentsply Professional, York, PA

IADR
IADR 2014  Abstract # 76
Impact of Different Fluoride Varnish Formulations on Enamel Demineralization Prevention
C. GONZALEZ-CABEZAS, University of Michigan, Ann Arbor, MI and S. FLANNAGAN, University of Michigan School of Dentistry, Ann Arbor, MI

IADR 2014  Abstract # 556
In-office Bleaching Effects on Bovine Teeth Treated with Fluoride Varnishes
M.H. OH1, J. KIM2, M.H. KIM3, S. SEOK3 and B.S. LIM3, 1Vericom, Anyang, South Korea, 2University of Washington, Seattle, WA, 3Seoul National University, School of Dentistry, Seoul, South Korea

IADR 2014  Abstract # 835
Two Calcium Phosphate Agents Effects on Enamel Demineralization and Remineralization
I.H. EL KALLA, Faculty of Dentistry; University of Mansoura, Mansoura, Egypt and R.A. ELAGAMY, Mnasoura University, Mnasoura, Egypt

IADR 2014  Abstract # 947
Fluoride, Calcium and Phosphate Ion Release from Dental Varnishes
T. SATO1, S. KATO1, S. HOTTA1, Y. ISHIHARA1, F. FUSEJIMA1 and T. KUMAGAI1, 1GC Corporation, Tokyo, Japan, 1GC Corp., Tokyo, Japan

CED
IADR 2013 CED  Abstract # 506
Fluoride Varnishes: Does Fluoride Release Correlate with Deposition on Enamel?
C. BOLIS, G. HÄRTL and U. LENDENMANN, R&D, Ivoclar Vivadent AG, Schaan, Liechtenstein

continued on next page >
Vanish™ XT Extended Contact Varnish
(Clinpro™ XT Varnish Durable Fluoride-Releasing Coating)

AADR

AADR 2014  Abstract # 260
Fluoride Release from Different Thickness Specimens of Dental Restorative Materials
K. OKUYAMA1, Y. KADOWAKI2, H. KOMATSU3, Y. FUNATO3, S. OKI3, N. HASHIMOTO3 and H. SANO4, 1Hokkaido University, Sapporo, Hokkaido, Japan,
2Hokkaido University, sapporo, Japan, 3Hokkaido University, Sapporo, Japan, 4Hokkaido University, Sapporo, Hokkaido, Japan
3M ESPE rejects any responsibility for the content of the abstracts (objectives, methods, results, conclusions) which have been reproduced unchanged in this brochure.

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.