Cementation Simplification with a Bioactive Cement

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What do you cement with?

Weigh the benefit of a bioactive cement vs. a bonding agent & adhesive cement. Evaluate the preparation design & moisture control.

Cementation
Cement Selection

Restoration Placement?

- Cemented
  - Margin placement
  - Moisture Tolerant
  - Retention Required
  - Materials
    - RMGI
    - Ceramir

- Bonded
  - Margin placement
  - Moisture Control
  - Technique Sensitive
  - Materials
    - Self Adhesives
    - Bonding agent (TE or SE) & luting resin

Cementation Material Options

- Glass Ionomers / RMGIs
- SE Resins
- Calcium Aluminate / Calcium Silicate
- Bonding Agents w/ Resins
Traditional Cementation Options

**Glass Ionomers**
- Acidic pH
- Moisture Tolerant
- Fluoride Release
- Degrades over time
- Low bond strength
- Biocompatibility: Fair
- Bioactivity: None
- Sealing Quality: Ok

**Resin Modified Glass Ionomers**
- Acidic pH
- Insoluble
- Moisture Tolerant
- Fluoride Release
- Stronger than Traditional GIs
- Degrades over time
- Improved bond strength
- Biocompatibility: Ok
- Bioactivity: None
- Sealing Quality: Ok
- Ceramic Primer on Restorations
CERAMIC PRIMER

- Feldspathic
- Leucite
- Lithium Disilicate
- Lithium Silicate
- Zirconia

Resin Modified Glass Ionomer Cements

- Use Ceramic Primer prior to try-in
- Clean with ethanol after try-in
- Keep tooth slightly moist and place RMGI cement as it will chemically cure to the tooth and the Ceramic Primer
- Still want to always have good prep design
Resin Modified Glass Ionomer Cement and a Ceramic Primer

- Lab sandblasts @ 30psi w/ 50 micron aluminum-oxide particles
- G-Multi Primer (MDP) prior to tryin
- Ultrasonic clean with ethanol
- Place FujiCEM2 RMGI cement in restoration
Cementation

20

21
Bonded Adhesion

Increasing strength demands
Resin Cement Options

**Self Adhesive Resin**
- Acidic/Neutral pH
- Not moisture tolerant
- Low-moderate initial bond strengths
- Decreased bond strength over time
- Water sorption
- Biocompatibility-Ok
- Bioactivity-None
- Sealing Quality-Ok

**Bonding Agent w/ Resin**
- Acidic/Neutral pH
- Not moisture tolerant
- Best initial bond strengths but can decreases w/time
- Decreased bond strength over time
- Water sorption
- Biocompatibility-Ok
- Bioactivity-None
- Sealing Quality-Good but technique sensitive

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**SE Resin Cements**

Self-Adhesive Resin Cements Without a Primer or Bonding Agent have less:
- Wettability
- Which Results in Less Contact to the Tooth
- Which May Result in a Less Durable Bond
- Acid Neutralization
- Prolonged Gel State
- Convenience
All Ceramic Crown Microleakage

Bonded Resin Cement  SE Auto Resins

After simulated aging through cyclic loading (1.2 million) and dye penetration test to detect Microleakage. LSU Dental School. IADR 2006, Abstract #2090.
Results & Conclusions

**Results:** Groups with primer had significantly higher shear bond strength (SBS) than the non-primed groups by factors of 16-25X for the dentin subgroups and 6-10X for enamel subgroups. With dentin bonding, the U with SEP samples were significantly higher than the enamel subgroup with the same treatment. Dentin bonding with “U with CSEP” was significantly higher than “SC with CSEP”.

**Conclusions:** Use of a self-etch primer on the tooth structure, in addition to the self-adhesive resin cements, significantly increases the SBS of the ‘all-in-one’ resin cements used in this study.
Traditional Resin Cementation

Conventional methods applied to the bonding of silica-based ceramics are not successful. You cannot acid etch and silanate the intaglio surface of metal oxide ceramics as you can with lithium disilicate (e.max) or other glass ceramic restorations.

HF acid does not sufficiently alter the surfaces of metal oxide ceramics, and conventional silane coupling agents cannot provide chemical bonds to these materials because of the lack of silica.

Zirconia Cases

Should be delivered from the lab having been sandblasted with aluminum-oxide particles. Research shows small particles (30 µm) @ low pressure (35 psi) to enhance resin bonds while minimizing surface damage.*
Tribochemical silica coating

Alternative methods for bonding to metal alloys and metal-oxide ceramics include tribochemical silica coating and other silica-coating methods. These methods embed silica particles into the metal alloy/metaloxide ceramic surfaces. Silane coupling and bonding agents used for conventional feldspathic porcelain can then be used to bond to the silica-modified surfaces. (ex. Rocatec Silicoating 3M/ESPE)

Prior to Try-in

- The internal surfaces should be coated with a ceramic/metal primer that contains adhesive monomers that chemically bond to metal oxides.*
- MDP has been shown to offer the most consistent bonds to zirconia
Silanes

Organo-Phosphate Monomer (MDP)

Universal Adhesives (w/MDP)

Silane Primers

Developed by Kuraray 1983

• Acidic Monomer Activates Silanes & Chemically Bonds to Metal Oxide Ceramics (Zirconia & Alumina).
• (Key Ingredient to make a Silane Universal)
• Hydrophilic & Hydrophobic
• Very Durable Dentin Bond
  (Creates An Insoluble, calcium Salt with Dentin)
• Is The Most Copied Monomer In Dentistry
• The Most Researched Monomer In Dentistry
• 20 + Years Of Research On Metal Oxide Ceramics (Zirconia & Alumina)
• Strongest & Most Durable Bond to Metal Oxide (Zirconia & Alumina) Ceramics
THE “NO-WATER” SILANE w/ MDP

INSTANT ACTIVATION

LESS DEGRADATION
(More Stable 2 Year Shelf-Life)

BONDS WITH OR WITHOUT HF ACID ETCHING

Zirconia Cleaning

- Try-in contaminates the surface more than if a ceramic primer is not present.
- Salvia contains phosphates so they compete for the same receptor sites as the ceramic primers
REVIEW: Ceramic Try-in

• Make sure it is sand blasted properly from lab
• Use a Ceramic Primer prior to try-in (unless using Calcium Aluminate Cement)
• Ultrasonic with ethanol after try-in
• No additional MDP Ceramic Primer needs to be used.
  Or
• Sandblast after try-in and use a MDP Ceramic Primer then follow cementation protocols

Zirconia Adjustments
(Ultradent & Clinician’s Choice)
Lithium Disilicate & Silicate, Leucite and Feldspathic restorations

IS AN ADHESIVE CEMENTATION SYSTEM THAT IS EASY-TO-USE, EFFICIENT AND HIGHLY EFFECTIVE
Tooth-colored resin restorations have an average replacement time of 5.7 years due to secondary caries precipitated by bond failure.

We challenged that current dentin adhesive designs that incorporate increasing concentrations of hydrophilic monomers are going in the wrong direction. Factors that compromise bond durability in restorative dentistry include:

- Water sorption
- Polymer swelling
- Decline in mechanical properties
- Leaching of hydrolyzed resin components

We refer you to the original source for further reading:

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3148178/
Bond Degredation


Resin-dentin bonds are not as durable as was previously thought. Microtensile bond strengths often fall 30% to 40% in 6 to 12 months.

Factors that compromise bond durability in restorative dentistry

Instability of hybrid layers problem may be more severe than we realize

Intact hybrid layers created by a simplified etch-and-rinse adhesive in caries-affected primary dentin partially disappeared after 6 months of intraoral function
Demineralizing dentin is like opening the Pandora’s box, releasing endogenous enzymes (Matrix Metalloproteinases - MMPs) that were trapped within the mineralized dentin matrix.

In the presence of water (such as that derived from water sorption or from adhesives, MMPs (2, 8 & 9) can breakdown collagen fibrils that are not protected by intrafibrillar minerals.

Courtesy Pacific University (Dr Marc Geissberger)
InstroN

- Ultra Tester (Ultradent)
- Ultra Jig (Ultadent)

Shear Bond Test Results - 2012
Maximum/Minimum Shear Bond Strength per Bonding Material

![Graph showing shear bond strength results for different bonding materials]
Zirconia Try-in Questions???

• The lab should have sandblasted the restoration at 30-50psi w/ 50 micron aluminum oxide.

• After try-in:
  • Ivoclean and silanate?
  • Ultrasonic with ethanol after try-in or steam clean then silanate?
  • Sand blast then ultrasonic and ethanol?
  • Zirconia silanate prior to try-in
    (Ultrasonic with ethanol after try-in)
  Sandblast after try-in and use a MDP based cement

What substrate are we treating?

:Cement Selection

:Tooth Preparation

3x Tubule Density Equals Higher Fluid & Increased Difficulty for Bonding 30% Decrease in Bond Strengths with most bonding systems.**
What substrate are we treating?

**Depth of Preparation**

3x Tubule Density Equals Higher Fluid & Increased Difficulty for Bonding 30% Decrease in Bond Strengths with most bonding systems.**

Full coverage ceramics and Zirconia
Blatz MB et al. JPD 2003
Al-Amleh B et al. J Oral Rehabil 2010
Wolfart M et al. Dent Mater 2007

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### Zirconia Ceramic Conditioning

<table>
<thead>
<tr>
<th>Zr Treated with</th>
<th>Clean</th>
<th>Treat</th>
<th>SBS, MPa</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td></td>
<td>Z-Prime</td>
<td>31.5 (8.4)a</td>
</tr>
<tr>
<td>Saliva</td>
<td>Water</td>
<td>Z-Prime</td>
<td>20.6 (7.1)b</td>
</tr>
<tr>
<td>Saliva</td>
<td>Ethanol</td>
<td>Z-Prime</td>
<td>20.3 (4.2)b</td>
</tr>
<tr>
<td>Saliva</td>
<td>Ivoclean</td>
<td>Z-Prime</td>
<td>32.0 (6.2)a</td>
</tr>
<tr>
<td>Saliva</td>
<td>Sandblast</td>
<td>Z-Prime</td>
<td>30.3 (6.7)a</td>
</tr>
<tr>
<td><strong>Z-Prime</strong>/Saliva</td>
<td>Ethanol</td>
<td>None</td>
<td>28.8 (7.7)a</td>
</tr>
</tbody>
</table>

- Prime the ceramic before trying in the mouth
- Do not use phosphoric acid to clean zirconia unless it has been primed
- Ethanol, acetone, and phosphoric acid can be used to clean ceramics after priming
- Phosphoric acid will react with the Zr surface - depalmitization of MDP to resurf
- Try-in contaminates Zr surface – saliva contains phospholipids
- Apply primer and wait several minutes for optimum chemical bond

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*Note: Values in parentheses are standard deviations.*
MDP-containing material bonds to Zirconia

Summary of Bond Strength Testing

- Primers producing excellent bond to IPS e.max all contained silane, although some silane-containing products were less effective.
- Primers producing excellent bond to zirconia and metal materials all contained MDP, although some MDP-containing products were less effective.
- Application of effective restoration primers increased bond strength to all tested substrates. Priming of zirconia was especially necessary to create a long-lasting bond when using resin cement.

Bonded Adhesion

1. Prepare Restoration Surface
   - Sand Blaster 30um @35psi
2. Ceramic Primer (MDP)
   - Etch Dentin 10-15 secs
Bonded Adhesion

60

Bonded Adhesion

61
Bonded Adhesion

Activa (Pulpdent)
Theracem (Bisco)

**Calcium & Fluoride Releasing**
- Continuous ion release¹

**Alkaline pH**
- Transitions from acidic to alkaline pH in minutes²

**Easy Clean-up**
- Specifically formulated to allow for quick and easy removal of cement
Cement Selection

• Alkaline pH 8.5
• Moisture Tolerant
• Self Sealing
• Apatite Formation
• Insoluble/No Degredation
• Stronger with time
• Semi / Translucent
• Biocompatibility-Excellent
• Bioactivity-Apatite formation
• No silane, conditioning, bonding

Ceramir® Crown & Bridge

Ceramir Crown & Bridge is indicated for permanent cementation of:
• Porcelain fused to metal crowns and bridges
• Metal (gold, etc.) crowns and bridges
• Gold inlays and onlays
• Cast or prefabricated metal posts
• Strengthened core all-zirconia or all-alumina ceramic crowns and bridges
• Lithium Disilicate (eMax)
• Stainless steel crowns
• Ortho bands and appliances
Bioactivity by Doxa

A reactive bioactive system that contributes to hydroxyapatite mineralization of hard tissue through ion release and alkaline pH.

Cement Selection

ADVANTAGES
- Easy to use
- Pleasant patient experience
- Saves time and money
- Minimizes the risk of secondary decay

Ceramir Crown & Bridge has the ability to remineralize demineralized dentin.

Minimizes the risk of secondary decay

Hardness of demineralized dentin in the vicinity of Ceramir Crown & Bridge. After two weeks of storage, the dentin close to the restoration is harder than the dentin prior to etching.

Scanning electron micrograph showing remineralization of demineralized dentine in the vicinity of Ceramir Crown & Bridge.

L.S. Alhuwayrini, Dentin Remineralization Around Ceramir Restoration https://repository.upenn.edu/dental_theses/17/
Cement Selection

Cementation Technique

Mix for 8-10 seconds
3-4 restorations

Ceramir C&B Comparison to other cement classes

<table>
<thead>
<tr>
<th>Material Class</th>
<th>Ceramic Crown &amp; Bridge</th>
<th>GERMGI</th>
<th>RESINS</th>
<th>SELF ADHESIVE RESIN</th>
<th>ZINC PHOSPHATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydroxy Apatite Formation</td>
<td>YES</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>Biocompatibility</td>
<td>EXCELLENT</td>
<td>try/OK</td>
<td>OK</td>
<td>OK</td>
<td>good</td>
</tr>
<tr>
<td>pH</td>
<td>BASIC</td>
<td>acidic</td>
<td>acidic</td>
<td>acidic</td>
<td>acidic</td>
</tr>
<tr>
<td>Post-op Sensitivity</td>
<td>NO</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Stability Over Time</td>
<td>STABLE</td>
<td>degrades</td>
<td>degrades</td>
<td>degrades</td>
<td>degrades</td>
</tr>
<tr>
<td>Integration Mechanism</td>
<td>NANO STRUCTURAL</td>
<td>micro-mechanical retention, chemical bonding/adhesion</td>
<td>micro-mechanical retention</td>
<td>adhesion/micro-mechanical retention</td>
<td>micro-mechanical retention</td>
</tr>
</tbody>
</table>
ADVANTAGES
• Easy to use
• Pleasant patient experience
• Saves time and money
• Minimizes the risk of secondary decay

Ceramir Crown & Bridge vs other dental cement material classes

<table>
<thead>
<tr>
<th></th>
<th>CERAMIC CROWN &amp; BRIDGE</th>
<th>GLASS IONOMER</th>
<th>RESIN-MODIFIED GLASS IONOMER</th>
<th>CONVENTIONAL AND ADHESIVE RESINS</th>
<th>SELF-ADHESIVE RESIN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easy clean-up</td>
<td>YES</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Pre-treatment needed</td>
<td>NO</td>
<td>No</td>
<td>Conditioning &amp; primers</td>
<td>Etching/bonding &amp; primers</td>
<td>Primers</td>
</tr>
<tr>
<td>Sets in a moist environment</td>
<td>YES</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Post-op sensitivity</td>
<td>NO</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Tissue friendly</td>
<td>YES</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Seals marginal gaps</td>
<td>YES</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Alkaline pH</td>
<td>YES</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Fluoride release</td>
<td>YES</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Shrinkage</td>
<td>NO</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Stable over time</td>
<td>YES</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Retention</td>
<td>HIGH</td>
<td>Low</td>
<td>Medium</td>
<td>High</td>
<td>High</td>
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</tbody>
</table>

Lithium Disilicate (eMax)

• Cleaning w/phosphate scavengers is not necessary
• Silane is contraindicated
• Tooth etching or conditioning is not necessary
• Bonding agent is not needed
Crown Retention

Results Zirconia crowns (Kg/F)

<table>
<thead>
<tr>
<th>Material</th>
<th>Result (Zirconia crowns) Kg/F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ceramir Crown &amp; Bridge</td>
<td>32.1 ± 6.3</td>
</tr>
<tr>
<td>RelyX Unicem (3M)</td>
<td>27.8 ± 11.3</td>
</tr>
<tr>
<td>Dyract Cem (Dentsply)</td>
<td>12.2 ± 3.1</td>
</tr>
<tr>
<td>Rely X Luting (3M)</td>
<td>10.9 ± 6.5</td>
</tr>
</tbody>
</table>

Cement Selection

A Bioactive Dental Luting Cement—Its Retentive Properties and 3-Year Clinical Findings

Steven R. Jefferies, MS, DDS, PhD; Cornelis H. Pamelier, DMD, DSc, PhD; David C. Appleby, DMD, MS, CD, FACP; Daniel Boston, DMD; and Jesper Lööf, PhD

ABSTRACT—A clinical validation study was conducted to determine the performance of a new bioactive dental cement.

Three year recall data yielded no loss of retention, no secondary caries, no marginal discoloration, and no subjective sensitivity. All restorations rated excellent for marginal integrity.
Cementation Technique

Zirconia Restorations
- Cleaning w/ phosphate scavengers is not necessary
- Silane is contraindicated
- Tooth etching or conditioning is not necessary
- No bonding agent necessary
Technique

Cement Selection
Figure 1. Basic experimental design for artificial gap (left) and microscopic photos of artificial gap changes over time during incubation in phosphate buffered saline (right).
Simplify Cementation
- Silane is contraindicated
- Restoration does not have to be cleaned after trying
- Tooth etching or conditioning is not necessary
- Bonding agent is not needed

Moisture Tolerant
No Sensitivity
Alkaline pH
Apatite Forming
Insoluble
Stronger With Time
Self Sealing

Lithium Disilicate (eMax) removal
Implant crown cementation concerns?

Missing Canine
Zirconia abutment and Empress crown
• “Can Dental Cement Composition Affect Dental Implant Success?” was accepted for publication in ACS Biomaterials Science & Engineering. The paper describes the interactions between different cement classes with cells and bacteria, concluding that Ceramir Bioceramic Implant Cement is the only material, of the materials tested, that can be considered biocompatible as per ISO 10993-5 standards.
Thank you!

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Questions?