Longevity of Restorations
Annual Failure Rates

- Amalgam restorations: 0-7%
- Direct Composites: 0-9%
- Glass Ionomers: 1.4-14%
- Composite Inlays: 0-11.8%
- Ceramic restorations: 0-7.5%
- CAD/CAM: 0-4.4%
- Gold Inlay-Onlay: 0-5.9%


Restoration Longevity- % failed/year

<table>
<thead>
<tr>
<th>Restoration</th>
<th>Range</th>
<th>Mean</th>
<th>LSD Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amalgam</td>
<td>0-7.4</td>
<td>3</td>
<td>C</td>
</tr>
<tr>
<td>Direct Composite</td>
<td>0-9</td>
<td>2.2</td>
<td>ABC</td>
</tr>
<tr>
<td>Composite Inlays + onlays</td>
<td>0-10</td>
<td>2.9</td>
<td>BC</td>
</tr>
<tr>
<td>Ceramic Inlays +</td>
<td>0-7.5</td>
<td>1.9</td>
<td>AB</td>
</tr>
<tr>
<td>CAD/CAM inlays +</td>
<td>0-5.6</td>
<td>1.7</td>
<td>A</td>
</tr>
<tr>
<td>Gold Inlays + onlays</td>
<td>0-5.9</td>
<td>1.4</td>
<td>A</td>
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ANNUAL FAILURE RATES OF RESTORATIONS

<table>
<thead>
<tr>
<th>Material</th>
<th>Number of Studies</th>
<th>Mean (SD)</th>
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<tbody>
<tr>
<td>1 Amalgam</td>
<td>42</td>
<td>3.0%(1.9%)</td>
</tr>
<tr>
<td>2 Direct Composite</td>
<td>51</td>
<td>2.2%(2.0%)</td>
</tr>
<tr>
<td>3 Compomer</td>
<td>7</td>
<td>7.1%(1.2%)</td>
</tr>
<tr>
<td>4 Glass Ionomer</td>
<td>6</td>
<td>7.2%(5.6%)</td>
</tr>
<tr>
<td>5 Ceramic Restorations</td>
<td>36</td>
<td>1.9%(1.8%)</td>
</tr>
<tr>
<td>6 CAD/CAM</td>
<td>20</td>
<td>1.7%(1.6%)</td>
</tr>
<tr>
<td>7 Cast gold Inlays and Onlays</td>
<td>19</td>
<td>1.4%(1.4%)</td>
</tr>
</tbody>
</table>

Comparing Dental Ceramics

<table>
<thead>
<tr>
<th>Ceramic</th>
<th>Brand</th>
<th>Composition</th>
<th>Cement</th>
</tr>
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<tbody>
<tr>
<td>Feldspatic</td>
<td>Vita, CEREC</td>
<td>Contains Si</td>
<td>Total etch resin</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Veneer Cem, Variolink 2</td>
</tr>
<tr>
<td>High Leucite</td>
<td>Finesse, Empress,</td>
<td>Contains Si</td>
<td>Total etch resin</td>
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<tr>
<td></td>
<td>OPC,</td>
<td></td>
<td>Veneer Cem, Variolink 2</td>
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<tr>
<td>Lithium Disilicate</td>
<td>Empress 2, e.max,</td>
<td>Contains Si</td>
<td>Total etch,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Veneer Cem, Variolink 2</td>
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<tr>
<td>Alumina</td>
<td>Procera, In-Ceram</td>
<td>No Si– Al core</td>
<td>Rely X, Rely X ARC,</td>
</tr>
<tr>
<td></td>
<td>Al</td>
<td></td>
<td>Unicem, Variolink 2</td>
</tr>
<tr>
<td>Zirconia</td>
<td>Lava, Cercon,</td>
<td>No Si – Zr core</td>
<td>Rely X, Rely X ARC,</td>
</tr>
<tr>
<td></td>
<td>Everest</td>
<td></td>
<td>Unicem,</td>
</tr>
</tbody>
</table>
How much enamel – preparation depth?

- Cervical 0.31 mm (0.17-0.52)
- Facial 0.75 mm (0.45-0.93)
- Incisal 0.79 mm (0.30-1.18)

S. S. Atsu J. Prosthet Dent. 2005; 94:336

Changing color

Color change need .2-.3 mm for each shade change (A2- A1)
- Substrate- enamel best dentin, metal, composite
- Tooth condition- excessive wear, cracks, habits.
- Seal? Best with enamel

Change color

- 110 feldspathic porcelain veneers- 50 patients; 46 incisal coverage, 64 no coverage. Evaluated 4 yrs.
- Survival -95.8% with incisal porcelain coverage and 85.5% without incisal coverage.
- 6/9 fractures in veneers without incisal coverage.


Veneers- Incisal coverage?

Step 2: Resin Cements-RelyX Veneer Cementation Kit
- Light Cured Cement
- Silane
- Bonding agent
- Try in pastes
Try in pastes- altering shade

3M Veneer Cementation Kit
Translucent, B .5, A1, A3, WO

Lute It

Try in paste

Cured Cement

ProCad color change with resin cement.

Staining Ceramic materials Chairside

IQ Luster Paste- GC America

Luster Paste IQ- GC America

Can be applied to ceramic with CTE 6.9-13.3
**HF etching – How long?**

- **Feldspathic Vita**
  - 9.5% HF up to 3 min

- **Leucite reinforced - Empress**
  - 5% HF, 1 min

- **Lithium disilicate – Empress 2, e.max**
  - 5% HF, 20 sec

---

**Porcelain Primers**

**Silane to Porcelain Bond**

- Porcelain
- Si-OH
- -H₂O

**DRY Silane Completely**
Apply porcelain primer – 1 or 2 Coats

Properly silanized surface is hydrophobic

Resin Cement Classification

- TOTAL ETCH --VLC, Chemical, Dual---
  - Use bonding agent
    - Variolink, Calibra, RelyX ARC, Nexus, Choice 2

- SELF ETCH- Priming step, no rinse
  - Panavia, Multilink

- SELF-ADHESIVE- nothing needed to apply or rinse
  - Unicem, Sprint, G Cem, BisCem, Maxcem Elite, Smart Cem 2

Total Etch Resin Cements-for veneer cementation

Veneer Cementation

- HF etch veneer
- Apply silane and dry
- Try in
- Etch tooth, rinse
- Apply bonding agent to tooth
- Cure
- Mix cement and place into veneer (VLC cement- veneer thickness
Vivastick vs Optrastick - Ivoclar

Adjusting proximal contacts

- Tanaka Bite-X
- Articulating Paste
- 847-679-1610

Comparing Dental Ceramics

Survival rate of e.max press FPD

- 36-3 unit FPD - 28 patients
- Preparation 1.5 occlusal and 1.2mm axial
- 16% ant and 84% posterior
- Connector 12mm² (4mm Ht x 3mm) anterior and 16 mm² (4x4) posterior
- 8 yr survival 93%
- Failures veneer chips - 6%, 2 endo, 2 recemented
- No retention difference Ketac Cem vs Syntac and Variolink 2


<table>
<thead>
<tr>
<th>Material</th>
<th>Flexural Strength [MPa]</th>
<th>Fracture Toughness [MPa·m^0.5]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Felspathic Porcelain</td>
<td>80</td>
<td>1.1</td>
</tr>
<tr>
<td>IPS Empress</td>
<td>120</td>
<td>1.2</td>
</tr>
<tr>
<td>IPS Empress 2</td>
<td>350</td>
<td>2.5</td>
</tr>
<tr>
<td>e Max</td>
<td>350-400</td>
<td>2.5</td>
</tr>
<tr>
<td>In-Ceram Alumina</td>
<td>400</td>
<td>4.5</td>
</tr>
<tr>
<td>In-Ceram Zirconia</td>
<td>550</td>
<td>5.5</td>
</tr>
<tr>
<td>Procera (Alumina)</td>
<td>600</td>
<td>6.0</td>
</tr>
<tr>
<td>Zirconia (CERCON, LAVA)</td>
<td>900-1100</td>
<td>7-11</td>
</tr>
</tbody>
</table>
e.max crowns survival

- Four patients (10 crowns) were dropouts.
- For 94 crowns, mean observation time 79.5 mos (range, 34–109.7 months).
- The cumulative survival rate (Kaplan–Meier) 97.4% @ 5 years and 94.8% @ 8 years.
- Crown location did not significantly have an impact on the survival (p=0.74).
- Cementation no significantly difference occurrence of complications (GI Vivaglass (31%) vs Bonded Syntac, Variolink II (69%) (p=0.17).


However- not so fast!

- All restorations“ 87% complication-free 36 FDPs
- 80% complication-free rate for 19 glass-ionomer cemented FDPs (complications: 1 endodontic treatment and 2 recementations)
- 94% complication-free rate for the 17 adhesively cemented FDPs (complication: 1 endodontic treatment).
- No significant differences between cementation groups (P = 0.318, log rank test).


- Adhesive technique (Variolink II) when:
  - Abutment height of 4 mm or less.
  - Angle of convergence more than 10°.
  - Conventional cementation GI cement when:
    - Angle of convergence <less than 10°.
    - Abutment height > 4 mm.
  - Allergy to adhesive.
  - Difficult isolation.

<table>
<thead>
<tr>
<th>Author/Year</th>
<th>Study</th>
<th>Method/ Sample size</th>
<th>Conclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td>J. A. Sorensen, M. Cruz, O. Raffeiner, H.R. Meredith, H. P. Foser</td>
<td>Clinical Lithium disilicate glass ceramic (LDGC) 3-unit FPDs</td>
<td>N=41 conventional FPDs, N=19 LDGC FPDs, 5 yrs.</td>
<td>Failure rate: Veneer chipping – 1.1% Core fracture – 0.7% +LDGC – 10.5% debonding at cementation interface</td>
</tr>
</tbody>
</table>

### e.max - Composition

**System:**
- Lithium disilicate crystals: about 70% coarse grained
- Lithium disilicate crystals in a glass matrix

**Additional components:**
- MgO, Al₂O₃, La₂O₃, CeO₂, V₂O₅, MnO₂, Er₂O₃, Tb₄O₇

**e.max CAD vs Pressed**
- Same 70% lithium disilicate crystal
- Difference in length and size of crystals
- Produces same CTE, MOE
- Flexural strength and Fracture toughness differ
- E.max Press is stronger and tougher

### Clinical evaluation of IPS e.max crowns: 2 yrs
- 62 IPS e.max crowns, cemented with 2 self etching resin cements.
  - 23 crowns: Multilink Automix
  - 23 crowns: Experimental self-adhesive cement
- No cases of crown fracture or surface chipping
- No reported sensitivity at 1 or 2 years with either cement.
- Alfa score: 86.9 percent for crowns cemented with a self-etching, dual-curing cement.
- Early results indicate that IPS e.max crowns may be an effective option for all-ceramic crowns.

Checking reduction

- Flexible Clearance Tabs
  Bella de St. Claire
  Cat # 0004006- 1mm
  # 004007- 1.5mm
  # 004008- 2mm

Bonding to e.max
**Bond to e.max**

5% HF, Silane, Saliva dried,

- Flexural strength of e.max after HF etching
  - Control vs 5% HF -15 sec, 5% HF -20 sec, 5% HF -40 sec, 5% HF -30 sec

---

**Contact angle**

Goniometer & Keyence 2000 Microscope - recorded distilled water contact angle on treated e.max

<table>
<thead>
<tr>
<th>Surfaces (e.max polished &amp; finished)</th>
<th>Contact angle ° (distilled water)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (e.max polished)</td>
<td>20</td>
</tr>
<tr>
<td>5% HF 20 sec</td>
<td>0</td>
</tr>
<tr>
<td>9.5%HF 60 sec</td>
<td>0</td>
</tr>
<tr>
<td>1 coat silane</td>
<td>40</td>
</tr>
<tr>
<td>2 coats silane</td>
<td>40</td>
</tr>
</tbody>
</table>
HF etch, rinse, apply silane then try in- then bond

Clinical study- resin and GI cemented ceramic inlays at 2 years.

- Dual cured resin cemented inlays had 2% failures.
- Glass ionomer cemented inlays had 15% failure.


e.max clinical

- 94 crowns, mean observation time was
- Survival rate (Kaplan–Meier) 97.4% @ 5 years and 94.8% @ 8 years.
- Crown location no impact on survival (p=00.74)
- Cementation no significant difference occurrence of complications (GI Vivaglass (31%) vs Bonded Syntac, Variolink II (69%) (p=00.17).


e.max press FPD 8yr-93%

- 36- 3 unit FPD in 28 patients
- Preparation 1.5 occlusal and 1.2mm axial
- 16% ant and 84% posterior
- Connector 12mm² (4mm Ht x3mm) anterior and 16 mm² (4x4) posterior
- Veneer chips 6%, 2 endo, 2 recemented
- No retention difference Ketac Cem vs Syntac and Variolink 2


- 81 -3 unit FPD e max pressed in 68 patients
- 8% ant and 92% posterior
- Connector 12mm ant and 16 mm2 posterior
- Cr retained FPD (48 mos) cemented with GI =20 or resin=16
- Inlay retained FPD =resin (37mos). 6 of inlay retained replaced (13%) failed due to debonding
- 4 year survival rate 100% for Cr-FPD and 89% for inlay retained FPD

However- not so fast!

- Success 87% for 36 FDPs
- 80% for 19 glass-ionomer cemented FDPs (complications: 1 endodontic treatment and 2 recementations)
- 94% for 17 adhesively cemented FDPs (complication: 1 endodontic treatment).
- No significant differences


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<tr>
<td>Procera (alumina)</td>
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<td>6.0</td>
</tr>
<tr>
<td>CERCON, LAVA</td>
<td>900-1100</td>
<td>7-11</td>
</tr>
</tbody>
</table>

Glidewell Laboratory 1 Million crowns / year

- Metal Ceramic: 28.6%
- All-Ceramic & Composite: 60.9%
- Full zirconia 39.9%
- Zirconia Based 9.8%
- Lithium Disilicate 16.3%
- Leucite reinforced 0.8%

* Source J. Schuck VP, P. Child CRA, 2011
* From Dr. Chiche
### Fundamentals

- Zirconium = element (Zr)
- Zirconia = ZrO$_2$ (dental zirconia)
- TZP = tetragonal zirconia polycrystals
- Zirconia = Y-TZP (Yttrium stabilized tetragonal Zirconia polycrystals).

### Zirconia

- Stabilization of tetragonal phase with oxides like CaO, CerO and Y$_2$O$_3$
- Zirconia is stabilized tetragonal to monoclinic suppressed (Metastable)
- Al adds strength and stability prevents water corrosion at grain boundaries
- Al$_2$O$_3$ = 0.25% - opaque
- Thermal expansion 9-10 x10$^{-6}$/C

---

Zirconia = Y-TZP (Yttrium stabilized tetragonal Zirconia polycrystals).

Ceramic Steel” Mechanical properties same as stainless steel alloys - Strength, toughness & Young’s modulus$^{1,2}$

Zirconia is metastable
3 polymorphs:
- Monoclinic
- Tetragonal
- Cubic

---


www.materialsdesign.com/zirconia.htm
Metastable Transformation Toughening of ZrO$_2$

ZrO$_2$ Resists Crack Propagation
- YTZP transformation toughening (phase transformation) to inhibit crack propagation.

Phase Transformation in ZrO$_2$
Squeezes the Crack

Response to Vickers Hardness test
At higher loads

Computer-controlled Milling Process Yields Exact Fit After Sintering

Alumina Zirconia

Vickers Hardness test, high magnification
Zirconia-based bridges (LAVA): at 5 years

- Veneer chipping 15.2%.

F.P. NOTHDURFT, P.R. ROUNTREE, and P.R. POSPIECH, Saarland JDR Abstract #0312, 2007.

Zirconia FPD vs PFM @ 3 yrs

- 30 patients with 3 or 4 units (Cercon).
- Occlusal reduction 1.5-2mm, axial reduction 1.5, chamfer margin .5mm subgingival.
- 110 u AlOx, 30 psi, alcohol, Panavia 21
- No framework fractures
- Veneering fractures 4%


Zirconia vs metal ceramic restorations


Clinical results of zirconia crowns and FDPs

<table>
<thead>
<tr>
<th>Authors</th>
<th>Material</th>
<th>Time Yrs</th>
<th>Restoration</th>
<th>#</th>
<th>Survival %</th>
<th>Core Fracture (%)</th>
<th>Veneer Fracture (%)</th>
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<tbody>
<tr>
<td>Cehreli</td>
<td>Cercon</td>
<td>2</td>
<td>Single crowns</td>
<td>15</td>
<td>-</td>
<td>7</td>
<td>0</td>
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<tr>
<td>Groten &amp; Huttig</td>
<td>Cercon Cercon Ceram Kiss</td>
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<td>54</td>
<td>98</td>
<td>0</td>
<td>9</td>
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<tr>
<td>Ortop (2009)</td>
<td>Procera - Vita Lumin - Noble Rondo Zir</td>
<td>3</td>
<td>Single crowns</td>
<td>204</td>
<td>92.7</td>
<td>0</td>
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<tr>
<td>Study</td>
<td>Material</td>
<td>Time Period</td>
<td>Type Restoration</td>
<td>Sample Size</td>
<td>Survival Rate (%)</td>
<td>Core Fracture (%)</td>
<td>Veneer Fracture (%)</td>
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<tr>
<td>---------------</td>
<td>---------------------</td>
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<td>-------------</td>
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<tr>
<td>Schmitt 2009</td>
<td>- Lava Ceram 4</td>
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<td>Single crowns</td>
<td>19</td>
<td>100</td>
<td>0</td>
<td>5</td>
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<td>- Cercon Ceram S 7</td>
<td>2</td>
<td>4- to 7- unit FDP</td>
<td>30</td>
<td>96.6</td>
<td>3</td>
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<td>Cercon Creation 21</td>
<td>2</td>
<td>3-unit FDP</td>
<td>21</td>
<td>-</td>
<td>0</td>
<td>14</td>
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<td>- Cercon Ceram S 5</td>
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<td>100</td>
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<td>25</td>
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<td>3-unit FDP</td>
<td>21</td>
<td>90.5</td>
<td>5</td>
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<td>- Cercon Ceram S 4</td>
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<td>99</td>
<td>94</td>
<td>1</td>
<td>13</td>
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<td>Wolfart 2009</td>
<td>- Cercon Ceram S 4</td>
<td>4</td>
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<td>24 34</td>
<td>96 92</td>
<td>0 0</td>
<td>13 12</td>
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<th>Time Period</th>
<th>Type Restoration</th>
<th>Sample Size</th>
<th>Survival Rate (%)</th>
<th>Core Fracture (%)</th>
<th>Veneer Fracture (%)</th>
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<tr>
<td>Sailer 2007</td>
<td>- Cercon Ceram Express 3</td>
<td>5</td>
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<td>- Lava Ceram 4</td>
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<td>38</td>
<td>100</td>
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<td>3</td>
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<td>- Lava Ceram 3</td>
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<td>3- to 4-unit FDP</td>
<td>27</td>
<td>100</td>
<td>0</td>
<td>11</td>
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<td>Vult von Steyern 2005</td>
<td>- DC Zirkon Vita D</td>
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<td>3- to 5-unit FDP</td>
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<td>-</td>
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<table>
<thead>
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<th>Study</th>
<th>Material</th>
<th>Time Period</th>
<th>Cr or FPD</th>
<th>Sample Size</th>
<th>Survival Rate (%)</th>
<th>Core Fracture (%)</th>
<th>Veneer Fracture (%)</th>
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<tbody>
<tr>
<td>Tinsche rt 2008</td>
<td>DC Zirkon Vita D</td>
<td>3</td>
<td>3- to 10-unit FDP/Cailiever</td>
<td>65</td>
<td>-</td>
<td>0</td>
<td>6</td>
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<tr>
<td>Edelhof 2008</td>
<td>Digident - Initial ZirKeramik GC</td>
<td>3</td>
<td>3- to 5-unit FDP</td>
<td>21</td>
<td>90.5</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>Molin &amp; Karlsson, 2008</td>
<td>Denzir Vita D - IPS Empress</td>
<td>5</td>
<td>3-unit FDP</td>
<td>19</td>
<td>100</td>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>
### Occlusal reduction guidelines for ceramic materials

- Feldspathic porcelain - 2mm
- E.max - 1.5mm
- Zirconia veneered - 2-2.5mm
- Monolithic zirconia - .4-1mm

### Fracture strength

- Monolithic and bilayered LAVA DVS and e. max molar crowns cemented (RelayX) to resin cores after load cycling 200,000 cycles @ 25N were measured and compared.

### Study Material Yrs Cr or FPD #’s Survival % Core Fracture (%) Veneer Fracture (%)

<table>
<thead>
<tr>
<th>Study</th>
<th>Material</th>
<th>Yrs</th>
<th>Cr or FPD</th>
<th>#’s</th>
<th>Survival %</th>
<th>Core Fracture (%)</th>
<th>Veneer Fracture (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nothdurft &amp; Pospiech, 2009</td>
<td>-Cercon Ceram Kiss</td>
<td>0.5</td>
<td>Implant-supported single crowns</td>
<td>40</td>
<td>-</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>Larsson 2006</td>
<td>-Denzir Esprident Triceram</td>
<td>1</td>
<td>Implant-supported FDP</td>
<td>113</td>
<td>-</td>
<td>0</td>
<td>53</td>
</tr>
<tr>
<td>Larsson 2010</td>
<td>-Cercon-Cercon Ceram S</td>
<td>3</td>
<td>Implant-supported full-arch FDP</td>
<td>10</td>
<td>100</td>
<td>0</td>
<td>34</td>
</tr>
</tbody>
</table>

#### In-vitro Studies on veneering porcelain Support

- “Better veneering support lowers chipping rates.”
- “Fracture strength increased by 30% with an anatomical core design.”
- “Crowns with an ‘anatomic core’ had significantly higher values than a 0.5 mm core.”

1. D. Steiger, M. Rosentritt, M. Behr et al., University Regensburg, Influence of core design on chipping of Zirconia crowns, CED Munich 2009, Abstract #71
2. J. FISCHER, University of Bern, Strength of zirconia single crowns related to coping design, IADR Baltimore 2005, Abstract # 0546
Master preparation # 30

Preparation scanned- resin preparation made

Fracture strength testing

- LAVA- .6mm
- Lava core and DVS 1.2mm
- LAVA core and hand layered- 1.2mm porcelain
- E.max 1.2mm
- E.max 1.5mm
- E.max + veneer 1.5mm

Crowns cemented with RMGI
Fracture strength of crown after 200,000 cycles RMGI

<table>
<thead>
<tr>
<th>Material</th>
<th>Fracture Load (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LAVA</td>
<td>1000</td>
</tr>
<tr>
<td>LAVA Hand ven.</td>
<td>1500</td>
</tr>
<tr>
<td>LAVA Monolithic</td>
<td>2000</td>
</tr>
<tr>
<td>e. max Monolithic</td>
<td>2500</td>
</tr>
<tr>
<td>e. max Monolithic (1.5mm)</td>
<td>3000</td>
</tr>
<tr>
<td>e. max Bilayered</td>
<td>3500</td>
</tr>
</tbody>
</table>

Stress strain curve

Compressive load (N) vs. Compressive extension (mm)

LAVA DVS

LAVA DVS

Compressive load (N) vs. Compressive extension (mm)

LAVA DVS

Zirconia

Ceramic Steel

Mechanical properties are in the same order of magnitude of stainless steel alloys - Strength, toughness & Young’s modulus.

Zirconia crystals:
- Monoclinic
- Tetragonal
- Cubic

www.materialsdesign.com/zirconia.htm
Ceramic vs tooth

Hardness:
- Enamel: 336 VHN
- IPS e.max: 591 VHN
- Lava Veneer: 530 VHN
- Lava Core: 1250 VHN

Generally ceramic materials
- High hardness
- Brittle


Ra of specimens:
- Ceramic blocks (7x11x6mm). Ra for polished zirconia (area measured) was 0.7 microns (cut-off 0.8 and surface filter 40).

Wear testing
- The enamel stylus and brass holders with ceramic blocks were placed in an 8 station wear machine. The wear test used a water and glycerin mixture and a 10N load with a 2 mm slide for 400,000 cycles at 1.2 Hz.

Enamel stylus
- Freshly extracted human bicuspid teeth.
- The cusp functioning against the ceramic was shaped using a cone diamond producing a uniform cusp as a stylus.
**Enamel Wear**

- 10N load with a 2 mm slide was cycled onto the ceramic for 400,000 cycles at 1.2 Hz.
### Wear of Enamel vs LAVA

#### Wear Conclusions

- Ceramic materials are wear-resistant.
- Ceramico3 greatest enamel wear.
- IPS e.max & Lava Veneer material no difference in enamel wear.
- Glazed Zirconia high enamel wear.
- Polished zirconia least wear.
- Roughness important.

---

**Wear of Material and Enamel**


**e.max and Lava- wear**
**Monolithic zirconia - advantages**

- Conventional cementation
- Occlusal reduction .4-.6 mm
- Tooth Colored
- Low wear to opposing enamel
- Strength, low chipping
- Thicker & Stronger FPD Connectors
- Economical

---

**Monolithic zirconia - concerns**

- Glazed wear opposing enamel
- Polish vs. over glaze- occlusal
- Opacity, color
- Retention short 2nd molars
- Long-term survival
- Force transmission - bruxer
- Removal

---

**Graphs**

- Zirconia Flexural Strength
- Diamond cutting zirconia
Cutting zirconia

• Cutting zirconia
• Duracut
• Komet

Adhesive cementation of Zr

Try in restoration – clean
Rocatec Soft or 3M ESPE
and silanize
Cement restoration with
resin cement ASAP after
silanization

CoJet Sand applied 10 sec,
Silane, then resin cement

Bond to Zirconia+ Cercon

<table>
<thead>
<tr>
<th>Bond to Zirconia+Cercon</th>
<th>A0X 50 µl CoJet 30µl</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>12</td>
<td>20.6</td>
</tr>
</tbody>
</table>

- 81-3 unit FPD e max pressed 68 patients
- 8% ant and 92% posterior
- Connector 12² mm ant and 16 mm² posterior
- Cr retained FPD (48 mos) GI cemented=20 or resin=16
- all inlay retained FPD =resin (37mos) 6 inlay retained replaced (13%) failed due to debonding
- 4 year survival rate 100% for FPD and 89% for inlay retained FPD

Classifying resin cements

- Composite resin cements
  - TOTAL ETCH- Variolink, Calibra, Choice 2, Nexus, Veneer Cementation Kit, RelyX ARC
  - SELF ETCHING- (self etching primer)
    Panavia, Multilink
  - SELF ADHESIVE- Unicem, Bis Cem, Max Cem Elite, Smart Cem 2

Microtensile bonds to dentin of total etch, self etch and self adhesive cements

- Total etch- RelyX ARC = 69.6 MPa
- Self-etching- Panavia F = 33.7 MPa
- Self adhesive- RelyX Unicem =12.5 MPa, RelyX U100= 15.3 MPa, Smart Cem 2= 8.5 MPa, G-Cem 16.9 MPa, Maxcem= 11.5, SeT = 4.6 MPa

Classifying resin cements

- Composite resin cements
  - TOTAL ETCH- Variolink, Calibra, Choice 2, Nexus, Veneer Cementation Kit, RelyX ARC
  - SELF ETCHING- (self etching primer) Panavia, Multilink
  - SELF ADHESIVE- Unicem, Bis Cem, Max Cem Elite, Smart Cem 2

Self Adhesive Cements

Crown retention with different cements

Crown Retention
- Apply Scotchbond Universal Adhesive
- No dual-cure activator needed
- Dual-cure activator in RelyX Ultimate Cement
- No VLC of Scotchbond Universal needed
- SBU primes enamel and dentin ceramic, zirconia, alumina, and alloy surfaces

Cr retention - Thermocycled -10,000 and load cycled - 20 N -100,000

LAVA Crown Retention

Volume Wear Data
Conclusions

• G-CEM LinkAce showed the least wear while Maxcem Elite showed the most wear of the dual cured resin cements.
• Zinc-Phosphate had significantly greater wear than RMGIs which had significantly greater wear than resin cements either dual or chemical cured.

Conclusions

• For dual cured cements, no wear difference was found between light & chemical cured mode (p>0.05)
• Exception Maxcem Elite where chemical curing showed greater wear than light curing (p=0.01).

Cements

• Glass Ionomer
  – Resin modified- RelyX, Fuji Plus, Fuji Cem, RelyX Plus
• Resin Cements
  – Total etch- Variolink II, RelyX Ultimate- most retention
  – Self priming- Panavia, Multilink- Medium
  – Self adhesive- Unicem 2, MaxCem Elite, Ace Link, G Cem- Least retention
### Ceramic vs Cement

<table>
<thead>
<tr>
<th>Ceramic</th>
<th>Examples</th>
<th>Bond/Cement</th>
<th>Type Cement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feldspathic</td>
<td>Vita, CEREC</td>
<td>Bond- total etch</td>
<td>Variolink 2, Rely X Veneer Cem</td>
</tr>
<tr>
<td>High Leucite</td>
<td>Finesse, Empress, OPC</td>
<td>Bond–total etch</td>
<td>Variolink 2, Rely X Veneer Cement</td>
</tr>
<tr>
<td>Lithium Disilicate</td>
<td>3G, Empress 2, e.max</td>
<td>Bond- total etch</td>
<td>Variolink 2, RelyX Ultimate-SBU</td>
</tr>
<tr>
<td>Alumina</td>
<td>Procera, In-Ceram Al</td>
<td>Cement, total, self etch, self adhesive</td>
<td>Rely X, Unicem 2, G Cem Link Ace, Speed Cem</td>
</tr>
<tr>
<td>Zirconia</td>
<td>Lava, Cercon, Zeno, ZirCad,</td>
<td>Cement, total, self etch, self adhesive</td>
<td>Rely X, SBU-RelyX Ultimate Unicem 2, G Cem</td>
</tr>
</tbody>
</table>

### Ivoclean
- Ivoclean is a cleaning paste to clean the bonding surfaces of indirect restorations after intraoral try-in.
- While phosphoric acid may be used to clean the surface of glass ceramic restorations, its surface-deactivating effect on zirconium-oxide ceramics and base metal alloys inhibits bonding. Restorations cleaned with Ivoclean after intraoral try-in demonstrated the highest bond strengths compared to other cleaning methods, regardless of material type.
- Allows try-in of pretreated restorations
- Reliable performance on ALL dental restorative materials
- Easy to use and economical

### What cement - ceramic
- Bond Si containing ceramic (feldspathetic, e.max)
- Bond when high and dry
- Bond for added retention
- With high strength ceramic restorations- Unicem 2 or RMGI (RelyX Plus or Fuji Plus)

### Bonding Zr Crowns
- If short preparations!
- Use CoJet Sand on intaglio surface, silane and dual cure cement
- Z Prime on intaglio, dry bond
- SBU and Rely X Ultimate
- Self Adhesive or RMGI when extra retention not needed