DENTAL CEMENTS for Luting and Bonding

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RETENTION BY DENTAL CEMENTS
Coarse and fine micromechanical retention

DENTAL JOINTS
ADHESIVE SYSTEM or LUTING CEMENT

ENAMEL, DENTIN > Liner, Base, Cement > Post and Core > Dental Amalgam > Implant >
< Composite, Amalgam < Cast Inlay, Onlay, or Crown < All-ceramic Inlay, Onlay, or Crown < Veneers, Maryland Bridges < Orthodontic Brackets

GOALS:
• Retention / resistance form
• Sealing (No fluid flow or ML)

CEMENT FACTS:
• No correlation of lab and clinical performance.
• RMGI for metal substructures and composite for ceramics.
• Failure occurs by fatigue – crack formation and propagation.
• Compositions and properties constantly changing.
• Cements are theoretically strong enough.
• Initial effectiveness requires “retention and sealing.”
• Cement more stable at enamel rather than dentin margins.
• Highest stress in cements occurs at margins.

CEMENT MICROSTRUCTURE

Zinc Phosphate (ZP)

Silicate (SC)

Zinc Silicophosphate (ZSP)

Cement Type: (Abbr.) LIQUID POWDER
Zinc Oxide Eugenol: ZOE (ZOE) Eugenol ZnO
Reinforced ZOE: (RZOE) Eugenol ZnO, Polymer, Rosin
ZOE-EBA: (EBA) Eugenol, EBA ZnO, Al₂O₃, Rosin
HV-EBA: (HV-EBA) H₂O ZnO, Al₂O₃, F-Al-Silicate glass
Zinc Phosphate: (ZP) H₃PO₄ / H₂O ZnO
Silicate: (SC) H₃PO₄ / H₂O F-Al-Silicate glass
Zinc Silicophosphate: (ZSP) H₃PO₄ / H₂O ZnO, Al₂O₃, F-Al-Silicate glass

Composite (with DBS) (CC, CP)

OVERVIEW OF DENTAL CEMENTS

POLYCARBOXYLATE

GLASS Ionomer

Resin-Modified (RMGI) (Monomers)

Composite (with DBS) (CC, CP) (Monomers) (Silicate glass fillers)
Dental Cement Timeline

1850 1900 1950 2000

- ZOE
- ZP
- SC
- PCC
- GI
- RMGI
- Compomer
- CC

Contemporary Practice

Generations of Cements

Zinc Phosphate
Polycarboxylate
Glass Ionomer

Resin-Modified Glass Ionomer
Composite Cement

What do you use ???


Dental Cement Use 1990 1995 2001
- EBA (ZOE) 1% --- ---
- Zinc Phosphate 22% 12% 10%
- Polycarboxylate 33% 17% 5%
- GI, RMGI, Compomer 42% 65% 75%
- Resin (Composite) 2% 6% 10%


Setting Reactions

% Conversion

TIME

Dental Cement Properties

Physical Properties:
- Coefficient of Thermal Expansion
- Thermal Conductivity

Mechanical Properties:
- Compressive Strength
- Tensile Strength
- Shear Strength
- Bond Strength

Chemical Properties:
- Solubility and Disintegration
- Absorption

Biological Properties:
- Chemical Irritation of Pulp During Setting

Dental Cement Properties

<table>
<thead>
<tr>
<th>Physical Properties</th>
<th>Chemical Properties</th>
<th>Mechanical Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Setting (°C)</td>
<td>Solubility (w/o, 37°C, 7d)</td>
<td>CS (psil, 37°C, 7d)</td>
</tr>
<tr>
<td>ZOE -31 to -85</td>
<td>0.02 to 0.10</td>
<td>2000 to 5500</td>
</tr>
<tr>
<td>R-ZOE</td>
<td>to -31 to</td>
<td>10000 to 15000</td>
</tr>
<tr>
<td>ZOE-EBA -12 to -24</td>
<td>to 0.40</td>
<td>to -40</td>
</tr>
<tr>
<td>HV-EBA</td>
<td>0.01</td>
<td>to -40</td>
</tr>
<tr>
<td>ZP +15 to -7</td>
<td>0.05 to 0.10</td>
<td>19000 to 21000</td>
</tr>
<tr>
<td>PC +50 to +420</td>
<td>0.04 to 0.08</td>
<td>8000 to 18000</td>
</tr>
<tr>
<td>GI</td>
<td>???</td>
<td>18000 to 24000</td>
</tr>
<tr>
<td>RMGI</td>
<td>???</td>
<td>24000 to 30000</td>
</tr>
<tr>
<td>Composite</td>
<td>???</td>
<td>35000 to 45000</td>
</tr>
</tbody>
</table>

???
In a clinical study of three luting cements, 547 bridges and 162 crowns were permanently cemented. Patients were recalled at 6-month intervals and the restorations were examined for looseness. A pattern of retainer type, cement type and retainer success was demonstrable.

5-Year Cement Retention: Crowns Bridges

<table>
<thead>
<tr>
<th>Cement Type</th>
<th>Crowns</th>
<th>Bridges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zinc Phosphate</td>
<td>100%</td>
<td>98%</td>
</tr>
<tr>
<td>Polycarboxylate</td>
<td>96%</td>
<td>95%</td>
</tr>
</tbody>
</table>

CEMENT AGING

SOLUBILITY and DISINTEGRATION

ADA Test

Multifactorial Solubility and Disintegration Events

- Water
- Cement
- Zn(OH)₂, Mg(OH)₂
- Zn(PO₄)₂
- H₂O, Lactic acid
- Na⁺, Cl⁻, F⁻, Ca⁺, K⁺

CEMENT MANIPULATION

“20 different experienced dental assistants mixing the same cement”

SUCCESS / FAILURE FACTORS:

1. Operator
2. Design Factors
3. Materials Factors
4. Intraoral Location Factors
5. Patient Factors

Compressive Strength (MPa)

\[ y = 100e^{-0.0598x} \]

R² = 0.9101
**ZINC PHOSPHATE CEMENT**

**Setting Reaction**

\[
\text{ZnO} + 2\text{H}_3\text{PO}_4 + \text{H}_2\text{O} \rightarrow \text{Zn}\{\text{H}_2\text{PO}_4\}_2 + \text{H}_2\text{O} \quad \text{(mixing)}
\]

\[
\text{Zn}\{\text{H}_2\text{PO}_4\}_2 + \text{nH}_2\text{O} \rightarrow \text{Zn}_3\{\text{PO}_4\}_2 + 4\text{H}_2\text{O}
\] (tertiary zinc phosphate)

**Cautions:**

Do not use on RDT < 1.0 mm

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**Mixing Procedure and Precautions**

**Zinc Phosphate Cement**

Chilled glass slab and dispensing P.

Dividing P portions and dispensing L.

Incremental addition and stropping.

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**CEMENT ACIDITY ON SETTING**

**Zinc Phosphate Cement**

<table>
<thead>
<tr>
<th>Mix</th>
<th>0</th>
<th>10</th>
<th>100</th>
<th>1,000</th>
<th>10,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time (minutes)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

Mixing, Working, Setting Intervals

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**SILICATE CEMENT**

Silico-phosphate = Traditional Ceramic Filling Material

- Residual Glass Particle
- Alumino-silico-phosphate GLASS

Si\(^{4+}\), Al\(^{3+}\), Ca\(^{2+}\), Na\(^{+}\), F\(^{-}\) Ions

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**POLYCARBOXYLATE CEMENT**

**Polymer-Based Dental Cement**

- ZnO
- PAA in H\(_2\)O
- ZnO
- Zn\(^{2+}\) - COO\(^-\) -\(\text{COO}^-\) -\(\text{COOH}\)

**Mixing Procedure and Precautions**

**Polycarboxylate Cement**

Dispensing P and L.

Folding P into L.

Stropping.
DENTAL CEMENT EXAMPLES

A. Zinc Oxide Eugenol Cements
   - ZOE 2200 (LD Caulk)
   - ZOE (J. Bird Moyer Co.)
   - ZOE Temporary (LD Caulk)
   - ZOGENOL (Stratford)
   - Reinforced ZOE Cements (RZO):
     - ZOE B+T (LD Caulk)
     - IRM (LD Caulk)
     - FYNAL (LD Caulk)
     - ZEBACEM (LD Caulk)
     - OPOTOW ALUMINA (Getz)

B. Hexyl Vanillate Cements (HV)
   - None currently marketed

C. Zinc Phosphate Cements (ZP)
   - MODERN TENACIN (LD Caulk)
   - FLECK'S EXTRAORDINARY (Mizzy)
   - SMITH'S ZINC CEMENT (Teledyne)
   - Ames Z--M (Teledyne)
   - KENT ZINC CEMENT (Stratford)
   - LAWCE--C+B Only (Lang)
   - SS--C (Stratford)
   - DROPSIN (Atwood Industries)
   - ELITE (I.D.T. Corp)

D. Silicate Cements (SC)

E. Zinc Silico--phosphate Cements (ZSP)
   - Ames PLASTIC Porcelain (Teledyne)
   - ASTRALIT (Premier)
   - SYNTREX F (Premier)
   - SILICAP (H. Justi)

F. Polycarboxylate Cements (PC)
   - TYLOK (LD Caulk)
   - DURELON (Premier)
   - CHEMIT (Harry J. Bosworth)
   - CARBOXYLON (3M)
   - POLY-F (DeTrey)

G. Glass Ionomer (GI)
   - ASPA (LD Caulk)
   - IONOMER (Denmat)
   - FUJI II (GC)
   - KETAC--CEM (ESPE)
   - BIOBOND LUTING (Harry J. Bosworth)
   - AQUACEM (DeTrey)
   - BASELINE (DeTrey)
   - RMGI (GC)
   - RELY-X LUTING (VITREMER CEMENT)
   - ADVANCE (LD Caulk)
   - PRINCIPLE (LD Caulk)

H. Resin Modified Glass Ionomer (RMGI)
   - FUJI I (GC)
   - FUJI PLUS (GC)
   - RELYT--X LUTING (VITREMER CEMENT)
   - ADVANCE (LD Caulk)
   - PRINCIPLE (LD Caulk)
   - NEXUS (Kerr)

I. Resin Cements
   - COMSPAN (LD Caulk)
   - PANAVIA F (Kuraray)
   - PANAVIA 21 (Kuraray)
   - ENFORCE (LD Caulk)
   - RESIN CEMENT (3M)
   - NEXUS (Kerr)
   - MEGBOND (Harry J. Bosworth)
   - DUO--CEMENT (Coltene)
   - CALIBRA (LD Caulk)
   - OPAL LUTING (3M)
   - COMPOLUTE (ESPE)
   - CEMENT--IT (Jeneric/Pentron)
   - CEMENT--IT (Jeneric/Pentron)
   - BUILD--IT (Jeneric/Pentron)

THANK YOU