DENTAL CEMENTS

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CEMENT:
A substance that hardens to act as a base, liner, filling material or adhesive to bind devices and prosthesis to tooth structure or to each other.

ACID BASE REACTION:
Chemical reaction between a compound with replaceable hydrogen ion (acid) and a substance with replaceable hydroxide ion (base) to yield water and salt

For aqueous cement liquid is acid and powder is base.
IMPORTANT TERMS

- **BASE:**
  A layer of insulating, sometimes medicated cement, placed in the deep portion of the preparation to protect the pulp from thermal or chemical injury.

- **CAVITY LINER:**
  Thin layer of cement used to protect the pulp.

- **LUTING AGENT:**
  A viscous material placed between a tooth structure and the prosthesis that hardens through chemical reaction to firmly attach prosthesis to the tooth structure.
CAVITY VARNISH:
A clear solution of resinous material or natural gum, capable of hardening without losing its transparency.
Used in cavity preparations to seal out dentinal tubules, reduce Microleakage or insulate pulp from thermal changes.

CERMET CEMENT:
Bonding of silver particles by fusing to glass powder particles through high temperature sintering of 2 powders.

ADMIX CEMENT:
Mixing spherical silver alloy powder with type II G.I.C powder.

DEW POINT:
Temperature at which dew deposits on a cooled glass mixing slab.
DENTAL CEMENTS
INTRODUCTION

- Supplied as two components:
  I. Powder.
  II. Liquid.
- Some have been reformulated in two pastes form.
- Liquids are acidic solutions (with exception of resin cements)
- Mixing these materials yields a paste like flowable material that sets within reasonable time.
- Setting is basically an acid base reaction.
- PH may range from 1.6 - 7.0.
IDEAL PROPERTIES OF DENTAL CEMENTS

i. Should be biocompatible.

ii. Should be insoluble in saliva & other oral fluids.

iii. Should set hard rapidly when used as base or lining in tooth cavity.

iv. Should have enough strength to withstand condensation forces under metallic restorations.

v. Should be bacteriostatic.

vi. Should provide insulation.

vii. Should have same translucency as tooth structure.
IDEAL PROPERTIES OF DENTAL CEMENTS

viii. Should be easy to manipulate.
ix. Should have adequate working time at room temperature.
x. Should bind chemically with enamel & dentin.
xi. Should have low viscosity and low film thickness when used as luting agent.
1) **Zinc OXIDE BASED CEMENTS:**

Powder of these cements contains mainly Zinc oxide which can react with variety of liquids.

i. Zinc Phosphate Cement.

ii. Zinc Oxide Eugenol Cement.

iii. Zinc Polycarboxylate Cement.

Cont...
CLASSIFICATION OF DENTAL CEMENTS

2) **ALUMINO SILICATE POWDER:**
   i. Silicate cement.
   ii. Glass ionomer cement.

3) **MISCELLANEOUS CEMENT:**
   i. Calcium hydroxide cement.
   ii. Cavity varnish.
   iii. Dentin bonding agents.

4) **RESIN CEMENT:**
CLASSIFICATION OF DENTAL CEMENTS

ON THE BASIS OF USES

1. CEMENTING OR LUTING CEMENTS:
   a) Zinc Phosphate Cement.
   b) Zinc Silico Phosphate Cement.
   c) Zinc Poly Carboxylate Cement.
   d) Glass Ionomer Cement.
   e) Resin Cement.

Cont....
CLASSIFICATION OF DENTAL CEMENTS

2. TEMPORARY OR INTERMEDIATE RESTORATION:
   a) Zinc Phosphate Cement.
   b) Zinc Poly Carboxylate Cement.
   c) Glass Ionomer Cement.
   d) Zinc oxide Eugenol Cement.

3. HIGH STRENGTH INSULATING BASES:
   a) Zinc Phosphate Cement.
   b) Zinc Poly Carboxylate Cement.
   c) Reinforced Oxide Eugenol Cement.
   d) Glass Ionomer Cement.
CLASSIFICATION OF DENTAL CEMENTS

4. **PULP CAPPING CEMENTS:**
   a) Calcium Hydroxide.
   b) Zinc Oxide Eugenol Cement.

5. **ANTERIOR TEETH RESTORATIVES:**
   a) Silicate Cement for Class III.
   b) Glass Ionomer Cement for Class III, V.

6. **PERIODONTAL PACK:**
   a) Zinc Oxide Eugenol Cement.

7. **CORE BUILD UP MATERIAL:**
   a) Metal Reinforced Glass Ionomer Cements.
These cements are available in Powder (zinc oxide) and Liquid (eugenol) & also in Paste-Paste formulation.

When Zinc oxide is mixed with Eugenol, it gets hard to give a cement with neutral pH (7.0).

ZnO Eugenol cements are extensively used in dentistry as:
- Temporary restorations.
- Pulp capping.
- Cavity liners.
- Thermal insulating bases.
- R.C.T sealants.
- Periodontal dressings.
ZINC OXIDE EUGENOL CEMENT

ZnO EUGENOL POWDER-LIQUID FORMULATION

ZnO EUGENOL PASTE-PASTE FORMULATION
ZINC OXIDE EUGENOL CEMENT

ZnO EUGENOL POWDER-LIQUID FORMULATION

ZnO EUGENOL PASTE-PASTE FORMULATION
**ZINC OXIDE EUGENOL CEMENT**

**ANSI/ADA classification for Zinc Oxide Eugenol Cement**

- **Type I ZnO cement**: Used for temporary cementation.
- **Type II ZnO cement**: Intended for long term cementation of or fixed prosthesis.
- **Type III ZnO cement**: Temporary filling and thermal insulating base.
- **Type IV ZnO cement**: Indicated for intermediate restorations.
ZINC OXIDE EUGENOL CEMENT

**COMPOSITION**

<table>
<thead>
<tr>
<th>POWDER</th>
<th>LIQUID</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZINC OXIDE = 69%</td>
<td>EUGENOL = 85%</td>
</tr>
<tr>
<td>MAGNESIUM OXIDE = 10%</td>
<td>OLIVE OIL = 15%</td>
</tr>
<tr>
<td>WHITE ROSIN = 29.3%</td>
<td></td>
</tr>
<tr>
<td>ZINC STEARATE = 1.0%</td>
<td></td>
</tr>
<tr>
<td>ZINC ACETATE = 0.7%</td>
<td></td>
</tr>
</tbody>
</table>

- White rosin reduces brittleness
- Zinc stearate & zinc acetate act as plasticizer.
- Olive oil masks the taste of eugenol.
- Acetic acid can be added as accelerator.
- Glycerine or glycol can be added as retarder.
MANIPULATION OF ZINC OXIDE EUGENOL CEMENT
MANIPULATION OF ZINC OXIDE EUGENOLCEMENT

- Powder & liquid are mixed on a glass slab or mixing paper with stainless steal spatula.
- Powder to liquid ratio of 4:1 or 6:1 by weight.
- Powder is mixed to liquid in bulk.
- Paste is formed.
- Mixing time is 30 - 60 seconds.
Zinc oxide in the presence of moisture reacts with eugenol to form zinc eugenolate.

\[
\text{ZnO} + \text{H}_2\text{O} \rightarrow \text{ZnOH} + \text{H} \text{(hydrolysis)} \\
\text{ZnOH} + 2\text{C}_{10}\text{H}_{12}\text{O}_2 \rightarrow \text{Zn(C}_{10}\text{H}_{11}\text{O}_2)_2 + \text{H}_2\text{O}
\]

**SETTING TIME:** 4-10 minutes

**SETTING TIME** is accelerated by

a. Moisture.
b. Particle size.
c. Powder to liquid ratio.
d. Addition of accelerators.
PROPERTIES OF SET ZINC OXIDE EUGENOL CEMENT

- Set cement has pH 7.0, so it is biocompatible and has very little effect on dental pulp.
- Set cement has a sedative effect on the dentinal tubules.
- Set cement has minimal dimensional change.
- Set cement is a good thermal insulator.
- Low compressive strength, strength is improved by additives.
- Set cement is radiopaque.
- Does not chemically bond to enamel or dentin.
- ZnO is bactericidal.
- Set cement has high water solubility, 2.5% disintegration occurs in first 24 hrs.
In order to improve compressive strength of ZnO cement additions have been made to either powder or liquid.

1) **RESIN BONDED ZINC OXIDE EUGENOL CEMENT**

<table>
<thead>
<tr>
<th>POWDER</th>
<th>LIQUID</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zinc Oxide</td>
<td>Eugenol</td>
</tr>
<tr>
<td>Hydrogenated Rosin= 10%</td>
<td>Polystyrene in 10% solution form</td>
</tr>
<tr>
<td>OR</td>
<td></td>
</tr>
<tr>
<td>Polymer particles = 20-40%</td>
<td></td>
</tr>
</tbody>
</table>

- Compressive strength is increased.
- Solubility in water is reduced.
## ZINC OXIDE EUGENOL CEMENT

### 2) E.B.A CEMENTS

**ETHOXY BENZOIC ACID CEMENT**

<table>
<thead>
<tr>
<th>POWDER</th>
<th>LIQUID</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zinc oxide = 60 - 70%</td>
<td>Eugenol = 37.5%</td>
</tr>
<tr>
<td>Fused alumina = 20 - 34%</td>
<td>O-Ethoxy benzoic acid = 62.5%</td>
</tr>
<tr>
<td>Hydrogenated Rosin = 6%</td>
<td></td>
</tr>
</tbody>
</table>

- Improved compressive strength.
- Low water solubility.
ZINC PHOSPHATE CEMENT

- Oldest of all luting cements.
- Longest track record.
- Standard with which newer systems are compared.
- Available in POWDER-LIQUID formulation.
- Two types:
  - **Type I:** Fine grain of powder and used for LUTING.
  - **Type II:** Used for thermal insulating base.
ZINC PHOSPHATE CEMENT

COMPOSITION OF POWDER

<table>
<thead>
<tr>
<th>INGREDIENTS</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZINC OXIDE</td>
<td>90.2%</td>
</tr>
<tr>
<td>MAGNESIUM OXIDE</td>
<td>8.2%</td>
</tr>
<tr>
<td>SILICONE DIOXIDE</td>
<td>1.4%</td>
</tr>
<tr>
<td>BISMITH OXIDE</td>
<td>GIVES SMOOTHNESS TO THE FRESHLY MIXED CEMENT</td>
</tr>
<tr>
<td>TANNIN FLUORIDE OR STANNOUS</td>
<td>SOURCE OF FLUORIDE IONS</td>
</tr>
<tr>
<td>FLUORIDE</td>
<td></td>
</tr>
</tbody>
</table>

Ingredients are heated to 1000-1400ºC for 4-8 hrs. They fuse to form a sintered mass which is grounded to powder form.
# Zinc Phosphate Cement

## Composition of Liquid

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orthophosphoric Acid</td>
<td>38.2%</td>
</tr>
<tr>
<td>Phosphoric Acid</td>
<td>16.2%</td>
</tr>
<tr>
<td>Aluminium / Zinc (act as buffer to control reactivity of liquid)</td>
<td>2.5%</td>
</tr>
<tr>
<td>Water</td>
<td>36%</td>
</tr>
</tbody>
</table>
MANIPULATION OF ZINC PHOSPHATE CEMENT
MANIPULATION OF ZINC PHOSPHATE CEMENT

- Mixing is done on a glass slab with a stainless steel spatula.
- In order to control the setting reaction glass slab can be chilled.
- Drop of liquid is placed and powder is added in small increments to get the required consistency.
  - Thick → for insulating base.
  - Thin → for Cementation purpose.
- Mixing time: 1 ½ minutes.
- Spatulation time: 15-20 sec for each increment.
- Setting time: 1-2 min (for thick consistency)
  5-9 min (for thin consistency)
When powder is mixed with liquid phosphoric acid attacks the surface of powder particles and release zinc ions into the liquid.

The spherical layer of zinc oxide is dissolved by acid.

\[ \text{ZnO} + \text{H}_3\text{PO}_4 \rightarrow \text{Zn(H}_3\text{PO}_4)_2 \]  
(acid ZnPO₄)

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

Setting time is accelerated by:
- P/L ratio.
- Particle size.
- Inc in temperature increases the setting reaction.

Buffer in the liquid slow down the rate of reaction and improves working time.
PROPERTIES OF SET ZINC PHOSPHATE CEMENT

1) Freshly mixed cement has PH 1.6-3.6. PH increases 4 in first 3 minutes. At the end of one hr PH is 6 and becomes neutral in 24 hrs.

2) In thick consistency cement base is very strong with good compressive strength. Strength reaches maximum after 24 hrs, although in first hour ¾ strength is achieved.

3) Set cement is brittle and has low tensile strength.

4) Cement is highly soluble in water for the first 24 hrs after setting. (thin mix more soluble than thick mix)

Cont....
5) Cement shows shrinkage of about 0.3% on setting.
6) Good insulator.
7) Does not have antibacterial properties.
8) Cement is radiopaque.
9) Does not adhere to tooth structure.

Combination of setting shrinkage, no antibacterial effect and no adhesion to tooth structure contribute to pulpal irritation associated with this cement.
USES OF
ZINC PHOSPHATE CEMENT

- As luting agent. (In low consistency a film of thickness of less than 25µm can be achieved)
- As insulator under amalgam fillings.
- As temporary filling material.
- For cementation of splints.
COPPER CEMENT

**POWDER**
- Copper compound with ZnO.
- With cuprous oxide $\rightarrow$ red cement powder is produced.
- With cupric oxide $\rightarrow$ black cement powder is produced.

**LIQUID:**
- Phosphoric acid
COPPER CEMENT

PROPERTIES

- Effect on pulp is greater than zinc phosphate cement.
- Bactericidal effect.
- Some black copper cements set in the presence of moisture and are used to fix splints on fractured jaw.
- In cases where cavities are deep zinc oxide eugenol is given followed by filling material.
ZINC SILICO PHOSPHATE CEMENT

A hybrid cement
(mixture of silicate and zinc phosphate cement)

- Zinc oxide as in zinc phosphate cement.
- Phosphoric acid.

Main objective is to combine
A. Esthetic qualities of silicate cement.
B. Lower solubility of phosphate cement.
PROPERTIES OF SET
ZINC SILICO PHOSPHATE CEMENT

PROPERTIES

- Intermediate properties between silicate & phosphate cement.
- Less translucent than silicate cement.
- Less irritating effect on pulp.
- Film thickness slightly more than zinc phosphate cement.
- 1% solubility in water.
- Fluoride content makes it anticariogenic.
- Initially PH is acidic but becomes neutral in 48 hrs.
USES OF ZINC SILICO PHOSPHATE CEMENT

SETTING TIME
3-5 min (thick consistency)
6-9 min (thin consistency)

- Temporary filling material.
- Cementing material for porcelain teeth.
ZINC POLYCARBOXYLATE CEMENT

- First cement that developed an adhesive bond to the tooth structure.
- Supplied as powder - liquid formulation.
# Zinc Polycarboxylate Cement Powder

<table>
<thead>
<tr>
<th>Component</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zinc Oxide</td>
<td>Main Ingredient</td>
</tr>
<tr>
<td>Calcium Hydroxide</td>
<td>Strength</td>
</tr>
<tr>
<td>Stannous Fluoride</td>
<td>Strength/Source of Fluoride Ions (15-20%)</td>
</tr>
<tr>
<td>Stannic Oxide</td>
<td>Substitute of MgO</td>
</tr>
</tbody>
</table>
ZINC POLYCARBOXYLATE CEMENT

**LIQUID**

<table>
<thead>
<tr>
<th>COMPONENT</th>
<th>FUNCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>AQUEOUS SOLUTION OF 40% POLYACRYLIC ACID</td>
<td>MAIN INGREDIENT</td>
</tr>
<tr>
<td>SODIUM HYDROXIDE, ITACONIC ACID, TARTARIC ACID</td>
<td>PH ADJUSTMENT (1.0-1.6)</td>
</tr>
</tbody>
</table>
ZINC POLYCARBOXYLATE CEMENT

- Cement is available in various forms.
  
a) Supplied with 2 liquids, both containing 40-42% polyacrylic acid but with different molecular weights.
    - Low viscosity liquid = 22,000
    - High viscosity liquid = 50,000
  
b) Same molecular weight but different concentrations of liquids.
    - 32% polyacrylic acid, mol wt 50,000
    - 42% polyacrylic acid, mol wt 50,000
  
c) Polycarboxylate cement as single component
    - Powder contains zinc oxide, MgO & freeze dried powder of polyacrylic acid.
      
      This single component is mixed with water.
      
      **PH of the mixture = 4.5**
MANIPULATION OF ZINC POLYCARBOXYLATE CEMENT
**ZINC POLYCARBOXYLATE CEMENT**

- Glass slab & stainless steel spatula is used.
- Powder liquid ratio 2:1.
- For water mixable cement, P/L ratio is 5:1.
- About half the powder is mixed at once.
- Mix powder & liquid for 30-40 sec.
- Mixing is continued till a glossy surface is obtained.
- Working time is much shorter as compared to zinc phosphate. (2.5 min)
- Alcohol is used to avoid adhesion of cement to the instrument.
Zinc ions react with carboxylic group in polyacrylic acid to form zinc polyacrylate.

\[
\text{CH}_2\text{-CHCOOH} + \text{ZnO} \rightarrow \text{CH}_2\text{-CHZnCOO}
\]
PROPERTIES OF SET ZINC POLYCARBOXYLATE CEMENT

- Good adhesion with the tooth structure.
- Set cement shows linear contraction (6%)
- Set cement absorbs water and becomes soft.
- Good thermal insulator.
- Mildly irritant to pulp.
- Radiopaque.
USES OF ZINC POLYCARBOXYLATE CEMENT

- Cementation of inlays and crowns.
- As insulating base under metallic restorations.
- As temporary / intermediate restoration.
CALCIUM HYDROXIDE

- Can be used in 2 forms.
  1) Cavity liners.
  2) Low strength bases.

- Calcium hydroxide can be,
  - A saline suspension with PH 12.
  - As modified forms with increased mechanical properties.

Dispensed in various forms
CALCIUM HYDROXIDE
CALCIIUM HYDROXIDE
CALCIUM HYDROXIDE

COMPOSITION OF CALCIUM HYDROXIDE AS CAVITY LINERS

1. Calcium hydroxide is suspended in a solvent:
   - Methyl ethyl ketone.
   - Ethyl alcohol.
   - Aqueous solution of ethyl cellulose.

2. A thickening agent:
   - Acrylic polymer beads / Barium sulphate.

3. Fluoride compound:
   - Calcium mono fluoro phosphate.
CALCIUM HYDROXIDE

PROPERTIES OF CALCIUM HYDROXIDE

Least irritant of all materials.
No mechanical strength.
No thermal insulation.
High solubility in water.
Anticariogenic due to fluoride release.
Kills microorganisms & heals pulp.
CALCIUM HYDROXIDE
LOW STRENGTH BASES

- Calcium hydroxide is mixed with a number of materials which increases its compressive strength.

- Most commonly available in the form of 2 pastes.
CALCIUM HYDROXIDE

COMPOSITION OF CALCIUM HYDROXIDE AS LOW STRENGTH BASES

BASE PASTE

- Tri basic calcium phosphate.
- Calcium tungstate.
- Zinc oxide in Glycol salisylate.

CATALYST PASTE

- Zinc oxide.
- Zinc stearate.
- Ethylene Toluene Sulphonamide.
- **Light cured calcium hydroxide base contains calcium hydroxide & Barium sulphate dispersed in Urethane dimethacrylate resin.**
**CALCIUM HYDROXIDE**

- **PROPERTIES OF CALCIUM HYDROXIDE**
  - Low tensile strength.
  - Low compressive strength.
  - Thermal insulator.
  - Acts as barrier against irritating constituents of other cements.
  - Stimulates reparative dentin.

- **Light cured Ca(OH)2 has**
  - pH 11.9.
  - Low water & acid solubility.
  - High compressive strength.
  - Low antibacterial effect.
THANK YOU

QUESTIONS???