DENTAL CEMENTS

PART1- ZINC OXIDE BASED CEMENTS
DENTAL CEMENTS

- Dental cements are materials made from two components, usually powder and liquid, mixed together into paste like consistency and hardens to a rigid solid.

**Uses:**
- Luting cements (temporary and permanent).
- Filling material (temporary and permanent).
- Pulp protection: cavity liners, varnishes and bases.
- Others: root canal sealer, periodontal pack and surgical dressing.

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I. Biological properties:
1. non-toxic and non-irritant
2. bacteriostatic.
4. Thermal insulation
5. Chemical protection:
6. Electrical insulation: protects the pulp from galvanic effects

II. Solubility:
They should be insoluble in saliva
III. Mechanical properties:
These must meet the requirements for the applications of dental cements, e.g. for cavity lining a cement should develop sufficient strength rapidly to enable a filling material to be packed on it.

IV. Optical properties:
They should be translucent and radio-opaque

V. Bonding:
A dental cement should ideally be adhesive

VI. Consistency & Film thickness:
They should have low film thickness.

N.B. Film thickness of dental cement depends on:
- Powder particle size.
- Powder/ liquid ratio.
- Viscosity of the mix
CLASSIFICATION OF DENTAL CEMENTS

1- Cements based on Zinc oxide:

2- Cements Based on Alumino Silicate glasses (Ion leachable glasses):

3- Resin Cements:

4- Others:
According to chief chemical ingredients

**Cements based on Zn Oxide**
- ZnO + Eugenol
  - ZnO eugenol cement

**Cements based on Alumino silicate glasses**
(Ion leachable glasses)
- Alumino silicate glass + Phosphoric acid
  - Silicate cement (Not used nowadays)

**Resin cements**
- Resin cements as luting

**Others**
- Varnishes & Liners
  - Ca hydroxide as liner and pulp capping

**Resin cements as luting**
- Alumino silicate glass + Polyacrylic acid
  - Glass ionomer cement (Widely used)

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ZINC OXIDE-EUGENOL CEMENTS

- Zinc oxide-eugenol cements have been widely used in dental field. They are available in powder-liquid form or in a ready-made paste of zinc oxide and eugenol.

**Applications:**

- 1- temporary cementation of crowns and fixed partial dentures.
- 2- In the provisional restoration of teeth.
- 3- As a cavity liner in deep cavity preparations
**Composition:**

**Powder:**
- Mainly zinc oxide
- Magnesium oxide
- Zinc acetate to improve strength

**Liquid:**
- Eugenol
- 15% olive oil.
SETTING REACTION:

- Zinc oxide + eugenol $\text{H}_2\text{O}$ $\rightarrow$ zinc eugenolate + unreacted ZnO
- The zinc eugenolate form matrix that hold unreacted ZnO. This reaction is called chelation reaction.
- Water is essential to the reaction to hydrolyze ZnO to form ions able to react with the eugenol liquid.
- The reaction is accelerated by zinc ions from Zinc salts.

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Microstructure

Its Cored structure the set material contains unreacted ZnO & free eugenol in Zn-eugenolate matrix.
Manipulation:

- Powder/liquid ratio 3 : 1, Powder is added to liquid in small increments until thin or thick consistency is obtained.

- Prolonged and vigorous spatulation using stainless steel spatula on a glass slab or oil resistant paper pad is required especially for thick mix.
1. Biological properties:

- The set cement has a pH of about 7 (neutral) and has little or no effect on the pulp when used in deep cavities. It has an **obtundent, sedative and palliative** effect on the pulp due to the presence of eugenol. It has **bacteriostatic** action due to the eugenol content.

- Eugenol containing cements may be **Allergic** to some patients. When in direct contact with soft tissues as lips and gingiva, the material is irritant.

2. Consistency and film thickness:

   It gives a film thickness of about 40 microns.

3. Solubility and disintegration:

   One of the **main disadvantages** of zinc oxide eugenol is their **high solubility** in the oral conditions due to leaching out of free eugenol from the set mass. Leached eugenol is then replaced by water which can cause hydrolysis of zinc eugenolate matrix and disintegration of the cement structure (higher solubility of all cements).
4. **Strength:**
Zinc oxide-eugenol cement has poor mechanical properties with compressive strength of about 15MPa for the luting cements. Tensile strength is 5MPa.

5. **Bonding:** By mechanical interlocking.

6. **Optical properties:** Opaque due to the presence of unreacted zinc oxide particles
MODIFICATIONS:

- One of the main disadvantages of zinc oxide eugenol cements is their high solubility and low mechanical properties.

- Additives have been added to the powder and to the liquid to improve the mechanical properties.
1. **Reinforced ZnO/E cement:**

<table>
<thead>
<tr>
<th>Modification in P:</th>
<th>Modification in L:</th>
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<tbody>
<tr>
<td>Polymer reinforce cement</td>
<td>Ethoxy benzoic acid cement</td>
</tr>
<tr>
<td>(Resin bonded cement)</td>
<td>(E.B.A. cement)</td>
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<table>
<thead>
<tr>
<th>P</th>
<th>L</th>
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<tbody>
<tr>
<td>ZnO 80%</td>
<td>Eugenol</td>
</tr>
<tr>
<td>PMMA 20%</td>
<td>Polystyrene 10%</td>
</tr>
<tr>
<td>ZnO</td>
<td>Eugenol 37.5%</td>
</tr>
<tr>
<td>Al₂O₃ 30%</td>
<td>EBA 62.5%</td>
</tr>
</tbody>
</table>

and is used for final cementation, as cement base and as intermediate restorative material **IRM™**.

Comp. str. $\rightarrow$ 85 Mpa

2. **Non Eugenol cement:**

For pts. Sensitive to eugenol.

3. **Rapid set ZnO/E cement:**

Low particle size.

Zn acetate & acetic acid $\rightarrow$ Accelerators.
N.B.

Zinc oxide eugenol is contraindicated to be used under resin based materials because it interferes with their polymerization and causes their discoloration.

Conventional ZnO and eugenol (non-reinforced) is contraindicated to be used under amalgam filling as it cannot withstand forces of condensation of amalgam, so reinforced types should be used.
ZINC PHOSPHATE CEMENTS:

Zinc phosphate cement is the oldest of the luting cements used in dentistry.

**Presentation**
- Powder and liquid

**composition:**
These materials are generally supplied as a powder and liquid which are mixed together by hand on a glass slab using stainless steel spatula.

**Powder:**
*Zinc oxide*: main constituent.
*Magnesium oxide*: maintain the white color and control the reactivity.
*Silica* and *alumina*: improve the mechanical properties.

**Liquid:**
*Aqueous solution of phosphoric acid*
*Zinc oxide* or *aluminum oxide*: Buffers.
These compounds stabilize the pH of the acid and reduce its reactivity. This will control working time and will help in adding adequate amounts of the powder to the liquid.
III-Manipulation

P/L ratio depends on purpose of using:

- 2.5:1 → for luting
- 3.5:1 → for cavity lining,

-Liquid is kept in a tightly closed bottle to avoid H₂O evaporation (↓pH & ↓setting rx)

-P&L are mixed on a glass slab using st. st. spatula, addition of P to L in small increments and over large area to dissipate heat of reaction,

-Cooled glass slab can be used but not below dew point (H₂O condensation occurs →↓ MT & phys. Prop.)

-WT&ST 3-6 min.
Setting reaction and microstructure (acid-base reaction):
On mixing the powder and liquid together a surface reaction occurs, the powder is partially dissolved in the acid resulting in the formation of zinc phosphate.

This reaction is followed by further reaction resulting in the formation of a hydrated zinc phosphate matrix which binds together the unreacted particles of zinc oxide. The reaction is rapid and exothermic and the result of the reaction is a cored structure.

. The set structure is composed of unreacted particles of zinc oxide in a matrix of zinc phosphate.
1. Biological properties:
- pH of freshly mixed cement = 1.3-3.6
- after 1 hr pH = 6
- after 48 hrs = neutral,
- irritant effect on the pulp due to initial acidity
- So in deep cavities sub-base of Ca(OH)$_2$ is placed under Zn-phosphate to prevent
2. **Thermal and electrical conductivity:**

The phosphate cement has adequate thermal insulating properties when used as a base in deep cavities under metallic restorations to protect pulp from thermal trauma.

3. **Consistency and film thickness (least film thickness of all cements):**

Zinc phosphate cement gives a maximum film thickness of 25 microns.

The consistency of zinc phosphate cement mix depends on the powder/liquid ratio and on the particle size of the zinc oxide powder.

4. **Solubility (lower solubility):**

Zinc phosphate luting exhibits solubility of about 0.1-0.2% after 24 hours immersion in water.
5. **strength**

The mixed cement reaches 50% of its final strength within the first 10 minutes and reaches its final strength after about 24 hours.

The compressive strength can vary from 95-135MPa, while the tensile strength is about 3-5MPa.

The cement is extremely brittle and is influenced by its very low tensile strength.

Zn phosphate cement has the **highest modulus of elasticity** among all cements that is why it is the most **suitable** under amalgam restorations.

6. **Bonding:**

Bonding of zinc phosphate cement is based on flow of the cement bonding of phosphate cement is based mainly on **mechanical interlocking**

7. **Optical properties:**

Opaque due to the presence of unreacted zinc oxide particles
APPLICATIONS:

- Permanent cementation (luting agent).
- Temporary filling.
- Base.
ZINC POLYCARBOXYLATE CEMENT
**Presentation:**

**Traditional form:** Powder and liquid.

**Proportioned capsules:** For mechanical mixing.

**Water settable cement:** The polyacrylic acid is freeze-dried and added to the powder. In such a case the liquid may be distilled water or a diluted solution of tartaric acid.
Composition:

Powder:
- Zinc oxide
- Magnesium oxide.
- Some cements contain alumina, silica, fluoride and stainless steel fibers.

Liquid:
- 30-40% aqueous solution of a copolymer of polyacrylic and carboxylic acids.
- Sodium hydroxide: adjust pH and viscosity
- Tartaric acid: control the setting reaction.
**Setting reaction and microstructure:**

- The setting reaction is an **acid-base** reaction between zinc oxide and the ionized copolymer of acrylic acid.

- The set cement is a zinc polyacrylate matrix that holds the unreacted powder particles (cored structure).

- The setting reaction proceeds rapidly when compared with that of zinc phosphate cement.
**MANIPULATION**

p/I ratio 1:1 → thin mix for cementation
-2:1 → thick mix as base

-Mixed on special paper using stst-spatula or better plastic spatula,
-Mixing should be completed within 30-40 seconds,
-Creamy mix, correct mix is viscous but mix flows back under its own weight or under pressure,
-Dispensing of L immediately before mixing to prevent H₂O evaporation and thickening,
-Extended working time using cooled glass slab or 1/2P incorporated into L at once

**NB:** mixed cement should only be used with glossy surface, otherwise initial setting and no free carboxylic gps for adhesio

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Properties:

1. Biological properties:
The polycarboxylate cements are acidic but not as irritant as zinc phosphate:
- Polyacrylic acid is weaker than phosphoric acid.
- Polyacid chains are too large and lack the mobility required to penetrate dentinal tubules.
- Rapid rise of pH of mixed cement on setting to approach 5.5-6.
- Bonding to tooth structure.

2. Film thickness:
The film thickness of polycarboxylate cement is slightly higher than that of zinc phosphate cement; it is about 25-45 microns.

3. Solubility and disintegration:
Solubility in distilled water after 24 hours varies from 0.1% to 0.2% by weight for zinc polycarboxylate cement which is less than that of zinc phosphate cement.
4. **Strength:**
The 24-hour compressive strength of the polycarboxylate cements for luting is in the range of 55-95MPa. This is less than that of the zinc phosphate cement while the tensile strength is in the range of 3.5-7.5MPa which is slightly higher than that of zinc phosphate cement.

5. **Bonding:**
One of the most important advantages of polycarboxylate cements is their ability to bond chemically to enamel and dentine.

Bonding of polycarboxylate cements to gold alloys is dependent on surface preparation therefore sandblasting is recommended.

6. **Optical properties:**
Because of the presence of zinc oxide, the material is opaque.

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Applications:
- Cementation of crowns and inlays (luting agent).
- Bases under restorations.

N.B.
- The zinc polycarboxylate cement should not be used for temporary cementation because it bonds chemically to the tooth structure.
Thank You