Zinc Oxide-Eugenol Cement
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• These cements have been used extensively in dentistry since the 1890's. Depending on their use they vary widely in their properties.

• To improve the strength many modified zinc oxide-eugenol cements have been introduced, e.g. EBA-alumina modified and polymer-reinforced zinc oxide-eugenol cements.

• Recently non-eugenol zinc oxide cements have become available. They are suitable for patients sensitive to eugenol.
Classification: 4 Types

• Type I ZOE - For temporary cementation.
• Type II ZOE - Permanent cementation.
• Type III ZOE - Temporary filling and thermal insulation.
• Type IV ZOE - Cavity liners.
Composition

- **Powder**
  - Zinc oxide 69.0% Principal ingredient
  - White rosin 29.3% To reduce brittleness of set cement
  - Zinc stearate 1.0% Accelerator, plasticizer
  - Zinc acetate 0.7% Accelerator, improves strength
  - Magnesium oxide Is added in some powders, acts with eugenol in a similar manner as zinc oxide.
• Liquid

• Eugenol 85% Reacts with zinc oxide

• Olive oil 15% Plasticizer.
Setting Reaction

• ZnO + H2O \rightarrow Zn(OH)2

• Zn(OH)2 + 2HE \rightarrow ZnE2 + 2H2O

• Base Acid Salt
  (Zinc hydroxide) (Eugenol) (Zinc eugenolate)
• **Setting Time** 4-10 minutes. The complete reaction between zinc oxide and eugenol takes about 12 hours. This is too slow for clinical convenience.
Factors Affecting Setting Time

1. Manufacture: The most active zinc oxide powders are those formed from zinc salts like zinc hydroxide and zinc carbonate by heating at 3000°C.

2. Particle size: Smaller zinc oxide particles set faster.

3. Accelerators: Alcohol and water.

4. Heat: Cooling the glass slab, slows the reaction.

5. Retarders: The set can be retarded with glycol and glycerine.

6. Powder to liquid ratio: Higher the ratio, faster the set.
Properties:
Mechanical Properties

- **Compressive strength**: They are relatively weak cements. The strength depends on what it is used for.
- The compressive strength therefore ranges from a low of 3 to 4 MPa upto 50-55 MPa. Particle size affects the strength.
- In general, the smaller the particle size, the stronger the cement. The strength can also be increased by reinforcing with alumina-EBA or polymers.
• Tensile strength: Ranges from 0.32 to 5.3 MPa.

• Modulus of elasticity  This is an important property for those cements intended for use as bases.
• **Thermal Properties** are approximately the same as for human dentin

• **Solubility and Disintegration**: The solubility of the set cement is highest among the cements (0.4% wt). They disintegrate in oral fluids. This breakdown is due to hydrolysis of the zinc eugenolate matrix to form zinc hydroxide and eugenol. Solubility is reduced by increasing the P/L ratio...
• **Film Thickness**: The film thickness of zinc oxide-eugenol cements (25 µm) is higher than other cements.

• **Adhesion**: They do not adhere well to enamel or dentin. This is one reason why they are not often used for final cementation of crowns and bridges. The other reasons are low strength and high solubility.
• **Biological Properties**: pH and effect on pulp: (pH is 6.6 to 8.0). They are the least irritating of all cements.

• **the** Bacteriostatic and obtundant properties: They inhibit the growth of bacteria and have soothing effect (obtundant) on the pulp in deep cavities, reducing pain.

• **Optical Properties**: The set cement is opaque.
Manipulation

• The bottles are shaken gently. Measured quantity of powder and liquid is dispensed onto a cool glass slab. The bulk of the powder is incorporated into the liquid and spatulated thoroughly in a circular motion with a stiff bladed stainless steel spatula. Smaller increments are then added until the mix is complete.
• **Setting Time** 4-10 minutes.

• ZOE cements set quickly in the mouth due to moisture and heat.
Modified Zinc Oxide-Eugenol Cements

• EBA-Alumina modified cements.

(Ethoxy benzoic acid cement)

• Polymer reinforced.

• Non- eugenol cements.
EBA-Alumina Modified Cements

• **Composition**
  
  **Powder**: Zinc oxide-70% & Alumina-30%.
  
  **Liquid**: EBA 62.5% (orthoethoxy benzoic acid) Eugenol-37.5%.

• **Properties**: Its properties are better than that of unmodified ZOE.

• **Setting Time**: 9.5 minutes
Polymer Reinforced Zinc Oxide-Eugenol Cement

Uses
• 1. Luting agent
• As base
• As temporary filling material and
• As cavity liner.
• **Composition** *Powder*
  Zinc oxide 70%
  Finely divided natural or synthetic resins.

• **Liquid**
  Eugenol
  Acetic acid  accelerator
  Thymol  antimicrobial
• **Properties**

• These cements have improved mechanical properties and the Pulp response Similar to unmodified ZOE-moderate

• **Manipulation**

• The proper powder/liquid is dispensed on a dry glass slab. The powder is mixed into the liquid in small portions with vigorous spatulation.

• *Working time* These cements have a long working time.
INTRODUCTION

Glass ionomer cement is a tooth coloured material, introduced by Wilson & Kent in 1972. Material was based on reaction between silicate glass powder & polyacrylic acid. They bond chemically to tooth structure & release fluoride for relatively long period.
CLASSIFICATION

Type I. For luting
Type II. For restoration
  - Type II.1 Restorative esthetic
  - Type II.2 Restorative reinforced
Type III. For liner & bases
Type IV. Fissure & sealent
Type V. As Orthodontic cement
Type VI. For core build up
presentation

a- Traditional form: powder and liquid.

b- Preproportioned capsules: for mechanical mixing.

c- Water settable cement:

The polycarboxylic acid is freeze dried and added to the powder.
COMPOSITION

Powder :-
Acid soluble calcium fluroalumino silicate glass.
Silica - 41.9%
Alumina - 28.6%
Aluminum fluoride - 1.6%
Calcium fluoride - 15.7%
Sodium fluoride - 9.3%
Aluminum phosphate - 3.8%

Fluoride portion act as ceramic flux.

Strontium,
Barium or zinc oxide provide radio opacity.
Liquid :-

1. Polyacrylic acid in the form co-polymer with itaconic acid & malice acid.
2. Tartaric acid: improves handling characteristic & increase working time.
3. Water: Medium of reaction & hydrates the reaction products.
Setting reaction

The setting reaction is an acid base reaction that undergoes the following stages on mixing the powder with liquid:

1) Dissolution .
2) Migration
3) Reaction and precipitation
Dissolution:

Dissolution of the surface glass particles by the acid i.e H+ attack to release cations (ca++, AL+++ ) and fluoride ions. Between 20% to 30% of the glass is decomposed by the acid attack.
Migration:

Migration of the surface ions Ca++, Al+++ and fluoride ions complex into the liquid. The divalent Ca++ ions will migrate first followed by the trivalent Al++ ions. The sodium ions form silica gel on the surface of the particles.
Reaction and precipitation:

The migrated Ca++ ions will react first with the carboxylic group of the acid to form the cross linked carboxylic salt gel leading to the initial set. This is followed by the reaction of the slowly migrate trivalent Al+++ ions. The later reaction takes longer time and results into a stronger cross linked cement.
The precipitation process of the carboxylic gel salts is a continuous process and may take 24 hours. Therefore, the setting material should be protected against premature exposure to saliva as it affects the setting and the surface hardness.
When the powder & liquid are mixed, Surface of glass particles are attacked by acid. then Ca, Al, sodium, & fluoride ions are leached into aqueous medium.
Water plays an important role in structure of cement.

After hardening, fresh cement is extremely prone to the cracking & crazing, due to drying of loosely bound water.

Hence these cements must be protected by application of varnish.
SETTING TIME

• Type I  4 - 5 minutes

• Type II  7 minutes
PROPERTIES

• Compressive strength:
  - Cement: 90-240 Mpa.

• Tensile strength: 14-24 Mpa.
**Biocompatibility** :-

- Pulpal response to glass ionomer cement is favorable.
- Pulpal response is mild due to
  - High buffering capacity of hydroxy apatite.
  - Large molecular weight of the polyacrylic acid, which prevents entry into dentinal tubules.

**Anticariogenic properties** :-

- Fluoride is released from glass ionomer at the time of mixing & lies within in matrix. Fluoride can be released out without affecting the physical properties of cement.
Solubility & Disintegration:

- Initial solubility is high due to leaching of intermediate products.

- The complete setting reaction takes place in 24 hrs, cement should be protected from saliva during this period (1.5%).
**Adhesion :-**

😊 Glass ionomer cement bonds chemically to the tooth structure.

😊 Bonding is due to reaction occur between carboxyl group of poly acid & calcium of hydroxyl apatite.

😊 Bonding with enamel is higher than that of dentin, due to greater inorganic content.
Esthetics :-
GIC is tooth coloured material & available in different shades.
Inferior to composites.
They lack translucency & rough surface texture.
Potential for discoloration & staining.
MANIPULATION

1. Preparation of tooth surface :-
The enamel & dentin are first cleaned with pumice slurry followed by swabbing with polyacrylic acid for 5 sec. After conditioning & rinsing, tooth surface should isolate & dry.

2. Proportioning & mixing :-
- Powder & liquid ratio is 3:1 by wt. Powder & liquid is dispensed just prior to mixing.
- First increment is incorporated rapidly to produce a homogenous milky consistency.
- Mixing done in folding method to preserves gel structure.
- Finished mix should have a glossy surface.
3. **Protection of cement during setting :-**

- Glass ionomer cement is extremely sensitive to air & water during setting.
- Immediately after placement into cavity, preshaped matrix is applied to it.

4. **Finishing :-**

- Excess material should be trimmed from margins.
- Hand instruments are preferred to rotary tools to avoid ditching.
- Further finishing is done after 24hrs.
5. Protection of cement after setting:

- Before dismissing the patient, restoration is again coated with the protective agent to protect trimmed area.
- Failure to protect for first 24hrs results in weaken cement.
**Advantages:**
- Inherent adhesion to the tooth surface.
- Good marginal seal.
- Anticariogenic property.
- Biocompatibility
- Minimal cavity preparation required.

**Disadvantages:**
- Low fracture resistance.
- Low wear resistance.
- Water sensitive during setting phase.
- Less esthetic compared to composite.
**Uses :-**

1. Anterior esthetic restoration material for class III & V restorations.
2. For luting.
3. For core build up.
4. For eroded area.
5. For atraumatic restorative treatment.
6. As an orthodontic bracket adhesive.
7. As restoration for deciduous teeth.
8. Used in lamination/ Sandwich technique.
MODIFICATIONS

1. **Water settable glass ionomer cement:**
   - Liquid is delivered in a freeze dried form, which is incorporated into the powder.
   - Liquid used is clean water.

2. **Resin modified glass ionomer cement:**
   - Powder component consists of ion leachable fluoroalumino silicate glass particles & initiator for light curing.
   - Liquid component consists of water & poly acrylic acid with methacrylate & hydroxyl ethyl methacrylate monomer.
These materials undergo setting reaction through two mechanisms.

a) Dual cure:

i- The conventional acid-base reaction which takes place when the powder and liquid are mixed.

ii) Polymerization reaction of the resin component i.e. free radical reaction when light is applied to the cement.
b) **Triple cure:**

To ensure effective polymerization of the resin part in deep cavities, the formulated cement will set through three reactions:

i) Conventional acid – base reaction.

ii) Light cure polymerization of the resin.

iii) Chemical cure polymerization of the resin
Giomer:

A hybrid of glass ionomer and resin composite having the properties of both.

Nano-ionomer:

Blend of fluoroaluminosilicate of glass.
3. **Metal modified glass ionomer cement:**

- Glass ionomer have been modified by addition of filler particles, to improve strength, fracture toughness & resistance to wear.

**Silver alloy admix / miracle mix:**

- This is made by mixing of spherical silver amalgam alloy powder with glass ionomer powder.

**Cermet:**

- Bonding of silver particles to glass ionomer particles by fusion through high temperature sintering.
Glass cermets can be used as:

1) Core build up restorations or as

2) A restoration for class I and II in deciduous teeth.

They have higher abrasion resistance higher flexure strength and higher fracture toughness than the conventional glass ionomers. Because of the metal content, they are opaque. They have lower fluoride release than conventional glass ionomers.
4. **Compomer** :-

Compomer is a composite resin that uses an ionomer glass which is the major component of glass ionomer as the filler. Small quantity of dehydrated polyalkenoic acid incorporated with filler particles, Setting reaction is light activated. Adhesive system used with compomer is based on acid etch found with all composite resin.
Light curing glass ionomers have the following advantages over the conventional types:

i) Better optical properties.

ii) Less sensitivity to moisture after setting

iii) Superior mechanical properties.

They are used as anterior restorative materials.

N.B. polyacide modified resin composite materials are more related to composite resin rather than glass ionomer materials.
Resin cementas
Classification of resin cement

1- Unfilled acrylic cement.

2- Composite resin cement.
Unfilled acrylic cement

Powder (polymer) + liquid (monomer).

Polymerization reaction

They were used for cementation of acrylic jacket crowns.
Composite resin cements

These types of filled resin cements replaced the unfilled resin types due to their superior properties.

- Conventional cements (acid etching).

* self cured composite cements.

* light cured types.

* dual cure types
- Adhesive resin cements.

They are self cured powder / liquid.

These cements are called phosphonate cements.

The end of phosphonate reacts with tooth structure or with a metal oxide. The phosphonate is very sensitive to oxygen so a gel is provided to coat the margins of restoration until the setting occurred.
Biological properties: irritant to the pulp.

Film thickness: the film thickness varies according to uses.

Bonding: according to type mechanical or chemical.

Strength: 180-260 Mpa.

Optical properties: Translucent or radio opaque.

Solubility: insoluble.
Cavity varnish and liners

Varnishes and liners are used for coating the freshly cut tooth structure of the prepared cavity.

The cavity varnish: is natural gum such as copal, rosin or a synthetic resin dissolve in an organic solvent such as acetone, chloroform or an ether.
The cavity varnish is applied to the cavity preparation with a brush or cotton pledget, the solvent is allowed to evaporate leaving a thin coating resin film on the surface. This process may be repeated two to three times to give a uniform resin layer.

The cavity liner: is a liquid in which calcium hydroxide and some zinc oxide are suspended in a solution of natural or synthetic resin.
Application

1) To seal the dentinal tubules and prevent penetration of chemicals into the pulp.

2) To act as a temporary protection against the loss of constituents from the surface of a filling material. Cavity varnishes are used as a surface coat over glass ionomer restoration.

3) To seal the dentinal tubules under amalgum restorations and prevent penetration of metallic ions into enamel and dentin thus reducing discoloration of the teeth, around amalgum restorations. A film of varnish under a metallic restoration is not an effective thermal insulator.
Calcium hydroxide cements

This material is supplied as two pastes in two collapsible tubes. One paste consists of a mixture of calcium hydroxide, zinc oxide and sulphonamide, the other paste consists of glycol salicylate, titanium dioxide and calcium sulphate. Light activated calcium hydroxide cements have become available.
Dycal
Properties

1) The freshly mixed cement is alkaline with a PH of 11-12. It has the ability to stimulate the pulp to lay down secondary dentin.

2) Solubility and disintegration: the calcium hydroxide is highly soluble.

1) The compressive strength of calcium hydroxide liner is very low about 5 PMa.
THANK YOU