

EUGENOL BASED CEMENTS

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INTRODUCTION:

Zinc oxide-eugenol cements have long been used to cement temporary restorations in teeth prepared for inlays, crowns, or fixed bridges, and a variety of products is available to the dentist. During the last 25 years, the properties of these materials have been studied, and numerous improvements in physical characteristics and manipulative qualities have been achieved. Little information has been available, however, on the clinical behaviour of the zinc oxide eugenol cements.

When certain types of Zinc oxide are mixed with eugenol, the mix sets to a hard cement that is compatible with both the hard and soft tissues of the mouth. Cements of this type have been used extensively since the 1890s. Simple mixtures of these two materials do not have great strength when compared with water or resin-based cements, and their use has been limited to situations in which strength is not important.

HISTORY:

- ❖ It is the essential constituent of oil of cloves, which has been used
- ❖ medically since the 4th century – by Molnar, 1942.
- ❖ Its use to relieve toothache was recorded – by Vigo in 16th century.
- ❖ Reactions with metal oxides – by Bonastre, 1827.

Earliest Zinc oxide chelate cements used creosote (King,



Later mixed with oil of cloves (Chisholm, 1873)

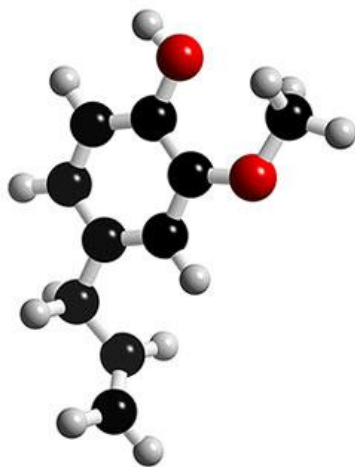


Oil of cloves used by itself (Flagg, 1875)



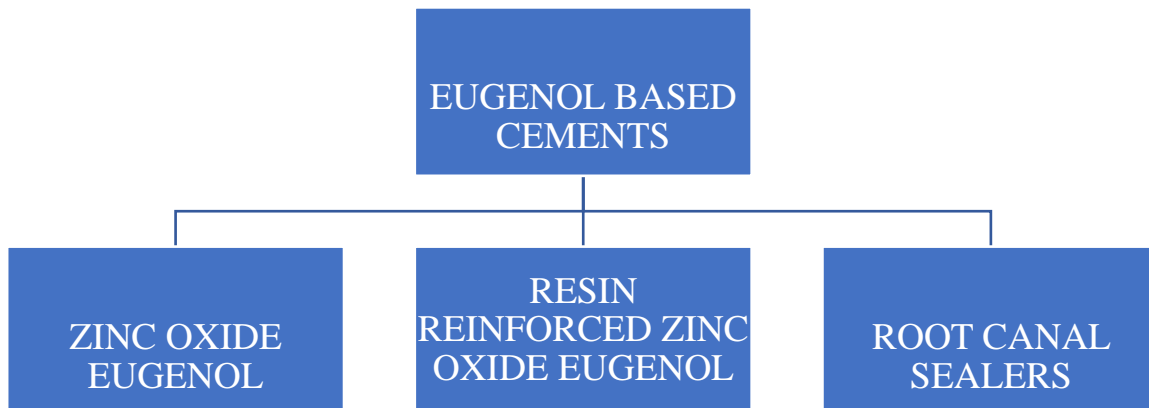
Finally the essential constituent, EUGENOL (Wessler, 1894)

CHEMISTRY OF EUGENOL:



- ❖ 4-Allyl 2-methoxy phenol
- ❖ Forms cements with ZnO,CuO,MgO,HgO,PbO –Braver,white &Moshonas 1958, Neilson 1963.
- ❖ Very weak acid, pk of 10.4 – Braver, Argentar & Durany, 1964
- ❖ It is a hydrogen bonded dimer, containing both intra and intermolecular hydrogen bonds – Gerner et al, 1966; Wilson & Mesley, 1972.

TYPES:





ZINC OXIDE EUGENOL:

- It is a mixture of zinc oxide and eugenol which sets to a hard cement that in suitable formulations is compatible with both hard and soft tissues of the mouth.
- ADA specification no.30
- Available as:
 - ⊙ powder and liquid
 - ⊙ Two pastes



CLASSIFICATION:

- Type I - Used for temporary cementation
- Type II – Intended for permanent cementation of restorations or appliances fabricated outside the mouth
- Type III – Used for temporary restorations and thermal - insulating bases
- Type IV – Used as a cavity liner.

COMPOSITION:

Powder:

- Zinc oxide – 69%
- White rosin – 29.3%
- Zinc stearate – 1%
- Zinc acetate – 0.7%



Liquid:

- Eugenol – 85%
- Olive oil – 15%

USES OF COMPONENTS:

- White rosin - Reduces the brittleness of the set cement
- Zinc stearate - Plasticizer
- Zinc acetate - Improve the strength of the cement
- Eugenol with olive oil - plasticizer

SETTING MECHANISM:

The setting mechanism for ZOE materials consists of zinc oxide hydrolysis

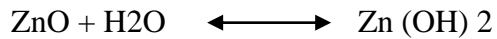


Reaction between zinc hydroxide and eugenol to form chelate.



The reaction is auto catalytic (water initiates the reaction and also a by-product).

Accelerator – zinc acetate dihydrate



Set zinc oxide-eugenol cement consists of a crystallite zinc eugenolate matrix that encases and binds the zinc oxide powder grains that have not been consumed in the reaction. Zinc eugenolate crystallites occur as outgrowths of the zinc oxide grains in the intergranular region. Water hydrolyzes the zinc eugenolate to zinc hydroxide, which acts as an indifferent binder, and eugenol, which is completely leached from the cement. Thus, the zinc oxide-eugenol cement is hydrolytically unstable and the degraded cement has little strength.

MANIPULATION:

1. Two paste system – Equal lengths of both the pastes are dispensed and mixed together to achieve a uniform color.
2. Powder and Liquid system – powder is incorporated into dispensed amount of liquid until a suitable consistency is achieved.



SETTING TIME:

Cement	Setting time (min)
Type I – Temporary cement	4 - 10
Type II – Permanent cement	4 - 10
Type III – Filling materials and bases	2 - 10
Type IV – Cavity liners	4 - 10

PHYSICAL PROPERTIES:

- ⊙ Film thickness –not more than 25 μ as described by the specification test.
- ⊙ Compressive strength:
 - ✓ Temporary cementation – 35 MPa
 - ✓ Permanent cementation, filling materials and bases - 25 MPa
 - ✓ Lining materials - 5 MPa
 - ✓ Permanent cementation - > 25 MPa
- ⊙ Solubility & disintegration:
 - For 24 hrs. – 2.5% for interim cementing materials
 - 1.5% for other cements

BIOCOMPATIBILITY:

- ⊙ Zinc oxide is effective as an antimicrobial agent (Sunzel et al.1990) and has been shown to provide cytoprotection to tissue cells.
- ⊙ Interactive toxic effects between zinc and rosin or resin acid was investigated using human polymorphonuclear leucocytes and gingival fibroblasts.

- ⊙ Rosin and resin acids were highly cytotoxic depending on the concentration.
- ⊙ The addition of zinc clearly reduced rosin and resin acid toxicity proportionally with increasing zinc concentration (Sunzel et al. 1997).

ROSIN:

- ⊙ Rosins are derived from a variety of conifers and are composed of approximately 90% resin acids.
- ⊙ The remaining parts are volatile and non-volatile compounds such as terpene alcohol, aldehydes and hydrocarbons.
- ⊙ The carbon group of resin acids is lipophilic, affecting the lipids in cell membranes and increasing the cell membrane permeability.
- ⊙ The resin acids are both antimicrobial and cytotoxic (Soderberg 1990).

BIOLOGIC PROPERTIES:

- ⊙ In a study by Serene et al. (1988), it was found that ZnOE sealers activated the complement system and thus an inflammatory reaction
- ⊙ Additionally, Guigand et al. (1999) found these sealers to be severely cytotoxic in fibroblast cultures.
- ⊙ These properties are mainly attributed to the eugenol component.

EUGENOL:

- ⊙ The toxic potency of eugenol has been demonstrated by Araki et al. (1993a, 1994) who found that the sealer Canals with eugenol as the liquid component was significantly more cytotoxic in permanent L929 cells and primary human periodontal ligament fibroblasts.

- ⊙ Similarly, it has been shown that the eugenol component of a sealer was highly cytotoxic to primary human periodontal ligament fibroblasts whereas the other sealer ingredients TiO₂, ZnO and BaSO₄ caused only slight toxic effects (Klaiber et al. 1981).
- ⊙ The effect of eugenol on the adherence of immunocompetent cells to substrate was studied with peritoneal macrophages from Wistar rats.
- ⊙ Even high dilutions (1:1000) of this phenol derivative significantly reduced the adhesion of macrophage.
- ⊙ Thus, eugenol could inhibit macrophage function and may influence inflammatory reactions in the periapical tissues (Segura & Jmenez-Rubio 1998).

APPLICATIONS:

- ⊙ For temporary and intermediate restorations
- ⊙ As cavity liners
- ⊙ Thermal insulating bases
- ⊙ Temporary and permanent luting cements
- ⊙ Root canal sealers
- ⊙ Periodontal dressings

RESIN REINFORCED ZINC OXIDE EUGENOL

- ⊙ Two compositional changes have been used to increase the strength of the cement for luting purposes.

COMPOSITION:

Powder

- Zinc oxide – 80%
- Methyl methacrylate / alumina – 20%

Liquid

- Ethoxy benzoic acid – 62.5%
- Eugenol – 37.5%

MANIPULATION:

- ⦿ The EBA-Alumina modified cement is dispensed according to the instructions.
- ⦿ Kneaded for 30 secs
- ⦿ Stopped for 60 seconds to develop a creamy consistency.
- ⦿ Oil of orange can be used to clean eugenol cements from cements.



PHYSICAL PROPERTIES:

- ⦿ Film thickness – 25 to 35 μm
- ⦿ The solubility and disintegration values of the EBA cements were considerably lower than those of the ZOE and zinc phosphate cements.

- ⊙ Increasing the powder-liquid ratio of the EBA cement from 1.4 to 1.5 gm/0.2 ml increased the compressive strength from 740 to 810 kg/sq cm.
- ⊙ A powder-liquid ratio of 1.7gm/0.2 ml yielded an easily mixed slurry that hardened to a one-week compressive strength of 955 kg/sq cm (13,600 psi), had a solubility and disintegration value of 0.05%, and had a film thickness of 26 μm.

COMPARISON OF PROPERTIES:

Physical properties	ZnO E	1.4gm/0 .2ml EBA	1.5gm/0.2 ml EBA	Zinc phosphat e
Mixing properties	good	good	fair	good
Consistency (mm)	....	41	39	30
Setting time (min)	7-8	8.5	8.5	7-8
One-day compressive strength (kg/sq cm)	140- 385	670	750	1,050
One-week compressive strength (kg/sq cm)	260	740	810	840 – 1,220
Solubility and disintegration (%)	0.10	0.04	.....	0.10 – 0.30
Film thickness (μ)	.....	40	39	<40

ENDODONTIC SEALERS:

- ⊙ Endodontic ZOE preparations have been used as a root canal sealer alone and with gutta percha and silver points.
- ⊙ ADA specification no.57
 - Type I – cements used with cores
 - Type II – Filling materials used without cores or sealer cements.

COMPOSITION:

- Pulp canal sealer – developed by Rickert
 - e.g.: Kerr pulp canal sealer; Kerr dental; Orange
 - Disadvantage – rapid setting time in high heat / humidity regions of the world.
- Pulp canal sealer EWT – 6 hrs working time.

RICKERT'S FORMULA:

Powder

- Zinc oxide – 41%
- Silver 30%
- White rosin – 17%
- Thymol iodide – 12%

Liquid

- Oil of cloves – 78%
- Canada balsam – 22%

USES OF COMPONENTS:

- ⊙ Rosin or Canada balsam is added for greater dentine adhesion.
- ⊙ Paraformaldehyde for antimicrobial and mummifying effects.
- ⊙ Germicides for antiseptic action
- ⊙ Corticosteroids for suppression of inflammation.

GROSSMAN'S FORMULA:

- ⊙ In 1958 it was formulated.
- ⊙ Roth's sealer/ Roth 801
- ⊙ Disadvantage – decomposed by water by continuous loss of eugenol

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weak, unstable material
- staining



COMPOSITION:

- Powder
 - Zinc oxide – 42%
 - Staybellite resin – 27%
 - Bismuth subcarbonate – 15%
 - Barium sulfate – 15%

- Sodium borate anhydrate – 1%
- Liquid
 - Eugenol – 100%

TUBLISEAL:

- ⊙ It's a two-paste system.
- ⊙ Advantage – ease of preparation
- ⊙ Disadvantage – rapid setting in presence of moisture.
- ⊙ E.g.: Seal apex regular, Seal apex EWT



COMPOSITION:

- Base paste
 - Barium sulfate
 - Mineral oil
 - Corn starch
 - Lecithin
- Catalyst paste
 - Polypale resin
 - Eugenol
 - Thymol iodide

WACH'S CEMENT:

- Base
 - Zinc oxide
 - Bismuth subnitrate
 - Bismuth subiodide
 - MgO & Ca(Po4)2

- Liquid
 - Oil of clove
 - Eucalyptol
 - Canada balsam
 - Beechwood creosote



- ⊙ Advantage:
 - ✓ Smooth consistency
- ⊙ Disadvantage:
 - ✓ odor of the liquid

MEDICATED VARIATIONS:

- ⊙ N2
- ⊙ RC2B
- ⊙ Spad
- ⊙ Endomethasone

Disadvantage:

- dissolve in fluid, hence break the seal.

NOGENOL:

- ⊙ Developed to overcome the irritating quality of eugenol.
- ⊙ Base: ZnO, Barium sulfate, vegetable oil.
- ⊙ Setting: hydrogenated rosin, Methyl abietate, Lauric acid, Chlorothymol, Salicylic acid.

ZnOE Vs CALCIUM HYDROXIDE:

- ⊙ A comparative study - one calcium phosphate cement (CPC) and two ZnOE sealers was performed with intentional overfilling in monkeys over a 6-month period.
- ⊙ CPC caused - mild inflammatory periapical reactions
- ⊙ whereas both ZnOE sealers (Grossman's sealer; Pharmacy, Glasgow, Royal Infirmary, UK) and N2 (Indrag- Agsa, Losone, Switzerland) - were severely irritating over the full 6-month duration (Hong et al.1991).

- ⊙ Despite the antimicrobial effect of rosin and zinc oxide on facultative bacteria,

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Zinc-releasing materials such as gutta-percha and ZnOE sealers, especially those releasing paraformaldehyde,

↓

Have been associated with maxillary sinus aspergillosis

(Beck-Mannagetta&Necek1986, Kobayashi 1995, Odell & Pertl1995).

- ⊙ It was hypothesized that paraformaldehyde penetrates the sinus through overfilled sealer and may cause tissue irritation and local necrosis of the sinus mucosa.

- ⊙ Subsequently, zinc oxide is released from the sealer, which may then promote growth of inhaled *Aspergillus conidia* (Beck-Mannagetta & Necek 1986).

CONCLUSION:

- ⊙ Zinc oxide eugenol are oil-based cements that have a sedative effect on the pulp and are especially useful for cementation on prepared teeth with exposed dentinal tubules.
- ⊙ The addition of reinforcing agents to zinc oxide eugenol cement has resulted in permanent luting cements.

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