Cement material

Also called cement base or lining, used underneath the filling material to act as a barrier against thermal, electrical and chemical stimuli also against irritant fillings. Cements are widely used in dentistry for a variety of applications. Some products are used primarily for:

- *Cavity lining* to protect the pulp and foundations and anchors for restorations.
- *Luting* applications to bond preformed restorations and orthodontic attachments in or on the tooth; also used for cementation of crown and bridge restorations.
- Sealing root canals as part of a course of *endodontic treatment.*
- Some cements are specifically formulated as filling materials.

Ideal requirement of dental cement

1- Adequate mechanical properties, adequate strength to withstand the force applied.
2- Protect the pulp from chemical irritants of the filling like acrylic monomers in some of resin based filling material.
3- Form a protective barrier against thermal stimuli especially under metallic restoration and acrylic based filling.
4- Protect the pulp from electrical current created when the amalgam restoration placed in contact with gold restoration.
5- Good adherence to avoid micro leakage, should not absorbed by oral fluid (low solubility) especially for luting material.
6- Not irritant to dental tissue and compatible with the filling materials.
7- Sufficient working time and setting time.
8- Easy to manipulate.
9- Dimensional stability.
10- Radio-opaque.

Classification of Cements

According to application

- Type I: Luting agents.
- Type II: Restorative applications.
- Type III: Liner or base applications.

According to the chemical composition

- Cements based on phosphoric acid:
  1. Zinc phosphate cement.
  2. Silicophosphate cement.
  3. Copper cement.
- Cements based on organo metallic cheated compounds:
  1. Zinc oxide/eugenol cement.
  2. Ortho-ethoxy benzoic acid (EBA).
  3. Calcium hydroxide cement.
- Cements based on polyalkenoic acid:
  1. Zinc polycarpoxylate cement.
  2. Glass ionomer cement.
- Polymeric cement.

Zinc phosphate cements

These materials are used for lining, luting and sometime as a temporary filling. Generally supplied as a powder and liquid which are mixed together by hand. Encapsulated products are available but are rarely used due to the extra cost involved.

Chemical composition

- ✓ Liquid: aqueous solution of phosphoric acid buffered by zinc oxide and aluminum oxide.
- ✓ Powder: zinc oxide (reactive component), magnesium oxide, and silica.

➢ ***Setting reaction:***

Phosphoric acid attacks the surface of the particles and release zinc ion which reacts with aluminum to form zinc aluminophosphate **gel** that holds unreacted particles, reaction is exothermic, controlled by incremental incorporation of powder into liquid. Cement is porous.

➢ ***Properties***

- ✓ Ultimate compressive strength for luting agent reach about 80 MPa, for lining material 140 MPa; so it can withstand the force applied during amalgam condensation. (5 minutes) should be left before placement of the amalgam filling.
- ✓ Modulus of elasticity 13(GPa).
- ✓ Good thermal insulator.
- ✓ Biological properties: The freshly mixed zinc phosphate is highly acidic with a pH of between 1 and 2 after mixing. Even after setting 1 hour, the pH may still be below 4. After 24 hours, the pH is usually 6 to 7. Pain on cementation is due not only to the free acidity of the mix but also to osmotic movement of fluid through the dentinal tubules, so in deep cavity a sub liner should be used.
- ✓ Retentive by mechanical retention sandblasting of crowns or inlays.
- ✓ Low solubility in water.
- ✓ Sufficient working and fast setting time.
- ✓ Moisture adversely affects cement.
- ✓ Proper film thickness when used as a luting agent (35-40μm) depends on particle size and P/L ratio.
- ✓ Radio-opaque; due to high amount of unreacted zinc oxide.

➢ ***Manipulation***

- P/L ratio is according to manufacturer instruction. Usually for cavity lining putty like consistency; while for the luting more fluid mix required to have adequate flow.

Low P/L ⟶ high acidity and week mix ⟶ irritation to pulp.
High P/L ⟶ thick mix ⟶ decrease setting time ⟶ insufficient working time.

- Powder is divided into increments that vary in size. It is critical that the powder be added to the liquid in very small increments. Cement must be spatulated slowly over a wide area of a cool, dry, thick glass slab to dissipate the heat so we have good working time and delay the set slightly, more powder incorporation will increase strength.

➢ ***Advantages and Disadvantages***

The main advantages of zinc phosphate cements are that they can be mixed easily and that they set sharply to a relatively strong mass from a fluid consistency. Unless the mix is extremely thin (for instance, with a very low powder/liquid ratio), the set cement has a strength that is adequate for clinical service, so manipulation is less critical than with other cements.
However, zinc phosphate's distinct disadvantages include pulpal irritation, lack of antibacterial action, brittleness, lack of adhesion, and solubility in oral fluids.

Silicophosphate cement

These materials have been available as a combination of zinc phosphate and silicate cements. The presence of the silicate glass provides a degree of translucency, improved strength, and ***fluoride release***.

➢ ***Applications***

Cementation of fixed restorations (luting cement) and orthodontic bands and temporary filling material.

➢ ***Composition and setting***

Powder consists of a blend of zinc oxide (zinc phosphate cement powder) and silicate glass (silicate cement powder) mechanically mixed or fused and reground. The silicate glass usually contains 12% to 25% fluoride.
The set cement consists of unreacted glass and zinc oxide particles bonded together by the aluminosilico-phosphate gel matrix. The set material is more soluble than zinc phosphate cement.

Copper cement

Black copper cement contains copper oxide. The powder is a mixture of zinc oxide and copper oxide while the liquid is phosphoric acid. Since a much lower powder/liquid ratio is necessary to obtain satisfactory manipulation characteristics with these cements, the mix is highly acidic, resulting in much greater pulpal irritation. Their solubility is higher and their strength is lower than zinc phosphate cements. Their bacteriostatic or anticariogenic properties seem to be good. Used in deciduous teeth.

Zinc oxide-eugenol cements

The basic combination of zinc oxide and eugenol finds its principal applications as a *cavity liner* in deep cavity preparations, root canal *sealing* but has certain additives, in the *cementation of temporary crowns* and temporary filling.

➢ ***Composition and setting***

- ✓ ***Powder*** is zinc oxide, silica, zinc acetate or sulfate may be present to accelerate the setting.
- ✓ ***Liquid*** is eugenol, olive oil (control viscosity) with small amounts of water, which is essential to the setting reaction.

A chemical reaction occurs between zinc oxide and eugenol, with the formation of zinc eugenolate.
The reaction is reversible because the zinc eugenolate is easily hydrolyzed by moisture to eugenol and zinc hydroxide. Thus, the cement disintegrates rapidly when exposed to oral conditions.

➢ ***Manipulation***

The zinc oxide is slowly wetted by the eugenol; therefore, prolonged and vigorous spatulation is required, especially for a thick mix. A powder/liquid ratio of 3:1 or 4:1 must be used for maximum strength.

➢ ***Properties***

- ✓ The working time is long because moisture is required for setting, setting time is controlled by moisture availability, accelerators, and the powder/liquid ratio. Mixes of cementing consistency set very slowly unless accelerators are used and/or a drop of water is added.
- ✓ Compressive strength 20 Mpa so not used under amalgam, the reinforced material has a higher strength 40 MPa so can be used under amalgam restorations.
- ✓ Tensile strength is very low because of the weak nature of the binding agent.
- ✓ Film thickness about 40 μm.
- ✓ The solubility is high, about 1.5% by weight in distilled water after 24 hours.
- ✓ Presence of eugenol in the set cement gives a sedative effect on the pulp in deep cavities. Also antibacterial action appears to facilitate pulpal healing. But in direct contact with connective tissue, the material is an irritant.
- ✓ Eugenol interferes with polymerization of resin based filling material cause discoloration so not used as alining with these filling.
- ✓ High solubility so not used as a luting agent. Effective thermal barrier.

➢ ***Advantages and Disadvantages***

The main advantage of these materials is their effect on the pulpal tissues, together with their good sealing ability and resistance to marginal penetration. Disadvantages include low strength and abrasion resistance, solubility and disintegration in oral fluids, and little anticariogenic action.

Calcium hydroxide cements

The value of calcium hydroxide as a **pulp-capping material** that facilitates the formation of reparative dentin. This action attributable to its alkaline pH and consequent antibacterial and protein-lyzing effect. Also used as a sub liner material.

➢ ***Composition and setting***

Supplied either as a suspension of Ca(OH)2 in water or two pastes: one paste contains calcium hydroxide, zinc oxide, and zinc salts (accelerator); the other contains glycol salicylate with inert fillers, pigments and radiopacifiers. Similar to the zinc oxide- eugenol reaction is greatly accelerated by moisture.

➢ ***Properties***

- ✓ Working and setting time depending on the availability of moisture. In the mouth, setting is rapid. It is not used as a luting agent. It can be used under resin based filling material.
- ✓ Low compressive and tensile strength.
- ✓ High solubility, marginal leakage cause complete dissolution of the material. So cannot used as a luting agent.
- ✓ Strong antibacterial action when free calcium hydroxide is available and to assist in remineralization of carious dentin. They facilitate the formation of dentin bridges (secondary dentin) when used for pulp capping on exposures. Their effect on exposed pulp is superior to that of zinc oxide-eugenol materials.

Polycarboxylate cement

The polycarboxylate cements were developed in the late 1960s as adhesive dental cements that would combine the strength properties of the phosphate system with the biologic acceptability of the zinc oxide- eugenol materials.

➢ ***Applications***

Cementation of cast alloy and porcelain restorations and orthodontic bands, as cavity liners or base materials, and as temporary restorative materials.

➢ ***Composition and setting***

- ✓ Powder is zinc oxide with, aluminum oxide filler to improve mechanical properties.
- ✓ Liquid is approximately a 40% aqueous solution of polyacrylic acid or an acrylic acid copolymer with other organic acids.

Zinc oxide reacts with the polyacrylic acid, forming a cross-linked structure of zinc polyacrylate. The set cement consists of the residual zinc oxide particles bonded together by this amorphous gel-like matrix.

➢ ***Properties***

- ✓ Setting is affected by the powder/liquid ratio, the reactivity of the zinc oxide, the particle size, the presence of additives, and the molecular weight and concentration of the polyacrylic acid. Working time can be substantially increased by mixing the material on a cold slab.
- ✓ Film thickness of 25 to 35 µm.
- ✓ Compressive strength lower than zinc phosphate cements 55 to 85 Mpa, but are significantly stronger in tension, tensile strength is 8 to 12 MPa at cementing consistency. Strength increases with the powder/liquid ratio 2:1 by weight.
- ✓ Higher solubility than zinc phosphate and glass ionomer cements but used widely as a luting agent.
- ✓ Bonding to clean enamel and dentin surfaces can occur forming an adhesive bond. The material also sticks to clean stainless steel with

strong bond, weak bond with gold, amalgam, chromiumcobalt; so used for bonding ortho bands.

- ✓ The acidic effect (irritant) of polycarboxylate cements on pulp is less than that of zinc phosphate, due to:
    - Polyacrylic acid is weaker than phosphoric acid.
    - Polyacrylic acid has a large molecules and lack mobility to penetrate dentinal tubules.

  But it is not used in deep cavity without sub liner.

➢ ***Advantages and Disadvantages***

The main advantages of these materials are the low irritation, adhesion to tooth substance and alloys, easy manipulation, strength, solubility, and film thickness properties comparable to those of zinc phosphate cements.
The disadvantages are the need for accurate proportioning for optimal properties and thus more critical manipulation, the lower compressive strength than zinc phosphate cements, the short working time and the need for clean surfaces to utilize the adhesion potential.

Glass-Ionomer Cement

These materials were formulated by bringing together the silicate and polyacrylate systems, leads to translucent, stronger cement that can be used for luting and restorative materials. Supplied as powder and liquid, powder with water or light cure glass ionomer cement.

➢ ***Applications***

Cementation of cast-alloy and porcelain restorations and orthodontic bands, as cavity liners or base materials, and as restorative materials.

➢ ***Composition and setting***

- ✓ ***Powder*** is calcium aluminum fluorosilicate glass.
- ✓ ***Liquid*** is a 47% solution of 2:1 polymeric acid-taconic acid in water.

  For the powder and water product: polyacrylic acid is incorporated in powder.

➢ ***Manipulation***

The powder/liquid ratio for luting is about 1.3:1.
The powder/water ratio is 3.3:1.
Mixing on a paper pad with stiff spatula, the powder is divided into two portions, mixing time is 30-60 seconds, and the cement should be used immediately because the working time is 2 minutes. Working time increased when mixing is done on cold slab.

➢ ***Properties***

- ✓ Setting time is in the range of 3 to 9 minutes.
- ✓ Film thickness is in the range of 25 to 35 μm,
- ✓ Compressive strength 90 to 140 MPa for lining materials and higher for filling material 60 TO 220 MPa.
- ✓ Low solubility. Good resistance to dissolution under oral conditions.
- ✓ Adhere well to the tooth structure (the free carboxyl group bonds to the hydroxyapetite crystals of enamel and dentin) giving initial adhesion.
- ✓ High acidity of freshly mix; but PH increased gradually.
- ✓ Leaching of fluoride give potentially carcinostatic effects.
- ✓ Translucent due to the presence of un-reacted glass.

➢ ***Advantages and Disadvantages***

The advantages of glass-ionomer cement materials include easy mixing, high strength and stiffness, leachable fluoride, good resistance to acid dissolution, potentially adhesive characteristics, and translucency.
The disadvantages include initial slow setting and moisture sensitivity, variable adhesive characteristics, radiolucency, and possible pulpal sensitivity.

Temporary Fillings materials

These are inserted as a temporary measure only, and can not used as permanent fillings as they are too soft and soluble and would not remain intact for long periods.

Indication of Temporary Fillings

- For permanent fillings requiring more than one visit, e.g. between visit of root canal treatment or inlays and onlay.
- After pulp capping in case of traumatic exposure, to give time for pulp healing process.
- Restoration of primary teeth.

Requirements of Temporary Fillings

- Should have good sealing and sedative ability and promote pulp healing.
- Reasonable strength, abrasion resistance, setting time and has low flow after setting.
- Easy to remove from the cavity. Radio-opaque.

Types of Temporary Fillings

1.Zinc oxide eugenol

According to ADA specification, there are four types of ZOE:

- Type I: temporary cementation.
- Type II: permanent cementation.
- Type III: temporary filling.
- Type IV: cavity liner (base).

✓ It has sedative effect on the tooth, reasonable sealing of the cavity; but it has low strength, low abrasive resistance and low flow after setting. Placement of ZOE t.f. should not be more than few days; maximum few weeks.

✓ The strength and abrasive resistance could be improved by adding 20-40 wt% of fine polymer particles and treating the surface of zinc oxide particles with carboxylic acid (reinforced ZOE type).

✓ Sufficient powder should be added to the liquid to achieve putty consistency (mixing is according to manipulation's instructions).

2.Zinc phosphate cement

- ✓ Higher strength and abrasive resistance than Zinc oxide eugenol, with relatively low solubility in oral fluids.
- ✓ It is irritant in the deep cavities.
- ✓ Bad adhesivity to a wet cavity.
- ✓ Higher P/L ratio is required for low acidity & high strength.
- ✓ Reinforced zinc phosphate is more durable and could be used when longer time for temporary filling is required.

3.Zinc silico phosphate cement

* Used as temporary filling because of flouride presence in its composition.

- ✓ Higher strength than Zinc phosphate and more translucent, used for longer time.

4.Gutta percha

- ✓ Composed of natural material obtained from natural tree (gutta percha), zinc oxide, wax or resin and metal salts to give radiopacity.
- ✓ Its applied by softining of gutta percha on the flame, then inserted into the cavity.
- ✓ Disadvantages: Pulpal pain and irritation result from heating. Micro leakage due to poor sealing ability. Low stregth.