Dental cements; Base materials

A base is any substance placed under a restoration (1-2 mm in thickness) that blocks out undercuts in the preparation, acts as a thermal or chemical barrier to the pulp, and/or controls the thickness of the overlying restoration. Bases should have sufficient strength to withstand forces of mastication and condensation of permanent restorations (mechanical protection to the pulp). Zinc-phosphate, polycarboxylate, zinc oxide-eugenol (IRM), glass ionomer and resin cements have all been historically used as bases for direct and indirect restorations.

1. Zinc Phosphate Cement:

Zinc phosphate cement is one of the widely used materials in dentistry. Introduced by Pierce in 1879, the cement has successfully been used for temporary restorations and as base and a luting agent. The cement is of two types as the following:

1. Type I (fine grain): Used for cementation. It forms the film thickness of less than 25 microns.
2. Type II (medium grain): Used as base. It forms film thickness between 25 and 40 microns.

Composition:

1. Powder:
ZnO90.2%, MgO—8.2%, SiO2: 1.4%, Bi2O3: 0.1%, and (BaO, Ba2SO4, CaO): 0.1%.
All the ingredients are sintered at temperatures between 1000°C and 1400°C into a cake that is subsequently ground into fine powder.

2. Liquid:
Phosphoric acid: 38.2%, Water: 36.0%, Aluminum or zinc phosphate: 16.2%, Zinc: 7.1%, Aluminum: 2.5%.
Both aluminum and zinc act as buffers to reduce the reactivity of the powder and liquid.

Manipulation of cement:

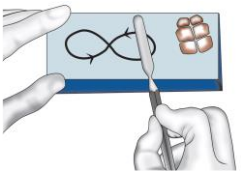
1. Working time ~ 5 minutes
2. Setting time ~ 2.5 to 8 minutes

3. Powder is measured and dispensed with scoop, a liquid is dispensed as drops. Cement mixing should be done on cool glass slab with a narrow bladed stainless steel spatula.

4. Lower the temperature of the slab during mixing, the longer will be the working time. This is advantageous because it allows incorporation of more powder into the liquid which results in greater compressive strength and lower solubility of the final cement.

5. Some clinicians prefer to mix the cement using the "frozen slab" technique which greatly extends the working time and allows incorporation of more powder into the liquid. But this method has disadvantage of incorporating water into the mix.

6. Since setting reaction is an exothermic type, the heat liberated while setting further accelerates the setting rate. To avoid that, the following should be done:

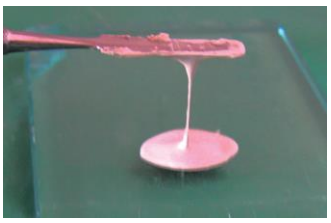


a. Using chilled glass slab.
b. Using smaller increment for initial mixing of cement.
c. Mixing on large area of glass slab.

7. Powder is divided into 5 to 8 increments in which initial two increments are smaller, third and fourth increments are bigger one and after that increments are again smaller in size.

8. For base or temporary restoration, consistency should be such that it can be rolled into a ball without sticking.

9. For luting, mixing is continued until a "1 inch string" is formed when spatula is pulled away from the glass slab.



Mechanical properties

1. Strength depends on its powder to liquid ratio; zinc phosphate cement achieves 75% of its ultimate strength within 1 hour.
2. Compressive strength of cement is 104 Mpa.
3. Tensile strength - 5.5 Mpa.
4. Modulus of Elasticity is 13.7 gigapascals. This high MOE makes the cement quite stiff and resistant to elastic deformation.

Biocompatibility

1. Because of presence of phosphoric acid, acidity of cement is quite high making it irritable.
2. PH of cement liquid is 2.0.
3. Two minutes after mixing, the pH is almost 2 and after 48 hours, it is 5.5.

Indications:

1. Reduces the thermal conductivity of metallic restorations.
2. Blocks undercuts in the preparation wall in case of cast restorations.

Uses of zinc phosphate cement:

1. Luting cement for crowns, inlays, posts and orthodontics band.
2. Used as base.
3. Temporary restoration.

Advantages:

1. High compressive strength
2. Thin film thickness.

Disadvantages:

1. Low initial pH.
2. Lack of an adhesion to tooth structure.
3. Lack of anticariogenic effect.
4. Soluble in water.

2. Zinc polycarboxylate cement/zinc polyacrylate cement:

It was one of the first chemically adhesive dental materials introduced in the 1960s.

Composition:

1. Powder:

It is similar to that of zinc phosphate cement powder. 4% stannous fluoride acts primarily as a strengthening agent.

2. Liquid:

Liquid is an aqueous solution of 32 to 43% polyacrylic acid.

Manipulation of zinc polycarboxylate cement:

1. Usually it is 1.5:1 powder to liquid ratio.
2. Cement should be mixed on surface that will not absorb liquid like glass slab or paper pads.
3. Liquid is dispensed just before mixing of the cement as the loss of water from liquid can result in increase in its viscosity.
4. Mix first-half of powder to liquid to obtain the maximum length of working time.
5. Mixed cement should be adapted to tooth till it is glossy in appearance. Loss of gloss makes it non-adhesive.

Working time and setting time:

- Working time ~ 2.5 minutes
- Setting time ~ 6-9 minutes

Biological considerations: pH of the liquid is 1.7 but increases rapidly after mixing. Zinc polycarboxylate is biocompatible because of the following reasons:

1. Size of polyacrylic acid molecule is bigger, this makes it less favorable to disperse into the dentinal tubules.
2. pH of the cement rises more rapidly when compared to that of zinc phosphate.

Uses of zinc polycarboxylate cement:

1. Luting cement for inlays or crowns.
2. Used as base.
3. Temporary restorations.

Advantages:

1. Adhesion to tooth structure.
2. Rapid rise in pH upon cementation.
3. Biocompatible.

Disadvantages

1. Short working time (2–3 minutes).
2. Does not resist plastic deformation under high masticatory stresses.

3. Zinc oxide eugenol base cement:

a. Could be selected for use as an insulating base and as a sedative base.
b. Cannot be used under composite resins, glass ionomers, or other resin restorations.
c. Excellent sealing quality.
d. Bacteriostatic in nature.
e. Anodyne effect.

4. Glass inomer:

Glass ionomer is compatible under composite resins (unlike ZOE cement) and easy to manipulate and place.

Compositions:

1. Liquid: Itaconic acid, tartaric acid, maleic acid, and water.
2. Powder: Zinc oxide, aluminum oxide, and calcium.

Advantages:

1. Anticariogenic property.
2. Chemical bond to tooth.
3. Well tolerated by the pulp.

Types of Glass Ionomer:

Type I: For the cementation of metal restorations and direct-bonded orthodontic brackets.

Type II: Designed for restoring areas of erosion near the gingiva.

Type III: Used as liners and dentin bonding agents.

5. Resin cement:

It consists of a resin matrix with inorganic fillers (silica or glass particles) that are bonded to the matrix with monomers (e.g. calibra and panavia). It bonds to tooth structures by the acid-etch and bonding agent. Resin cement can be polymerized either by chemical reaction (self cure), light activation (light cure), or both (dual cure).

Properties:

1. Insoluble in oral fluids.
2. It has large filler particles which improve mechanical properties (strength) and reduce polymerization shrinkage.
3. Some resin cements have fluoride which act as anti-cariogenic factor, and reduce the resin cement sensitivity.

Uses:

1. Used as luting cement.
2. Used as a base material.

Reference:

Textbook of operative dentistry. Nisha Garg and Amit Garg. (2015).