DENTAL MATERIAL

م.د.رامز سقيرق

Requirements of ideal cements

A. General properties:

1) They should be non toxic, non irritant to pulp and other tissues, insoluble in oral fluids.

2) They should have antibacterial effect (bactericidal better than bacteriostatic).

3) They should have obtunding effect.

4) They should high mechanical properties.

5) They should have good optical properties.

6) They should adhere chemically to tooth structure.

B. When used as luting: they must have low viscosity to give film thickness.

C. If used as cavity bases or liners: they must provide thermal, electrical, and chemical insulation.

D. When used as filling material: they should match tooth structure in thermal properties, and have minimal dimensional changes on setting

No single material can fulfill all of these requirements.

Definitions

Luting: the use of moldable substance to seal a space between two components. Most dental treatments necessitate attachment of prostheses to the teeth by means of luting agent.

Cements bases: A thick layer of cement (>0.75mm) is applied under restoration to protect pulp against injuries.

Uses of dental cements

A) Luting agent:

1) Temporary cement

2) Permanent cement

B) Pulp protection or cavity sealer:

1) Cavity varnish 2) Liner 3) Base

C) Filling

1) Temporary filling

2) Permanent filling

D) Others:

1) Root canal sealer

2) Giving and periodical packs

Classification of dental cements

I. According to mean of setting:

A. Acid-base reaction:- These cements are typically powder/liquid system. Their liquids are acids . When powder are bases; insoluble in oral fluid. When mixed together → Acid- base reaction:

1) Zinc phosphate cement

2) Zinc oxide- eugenol cements

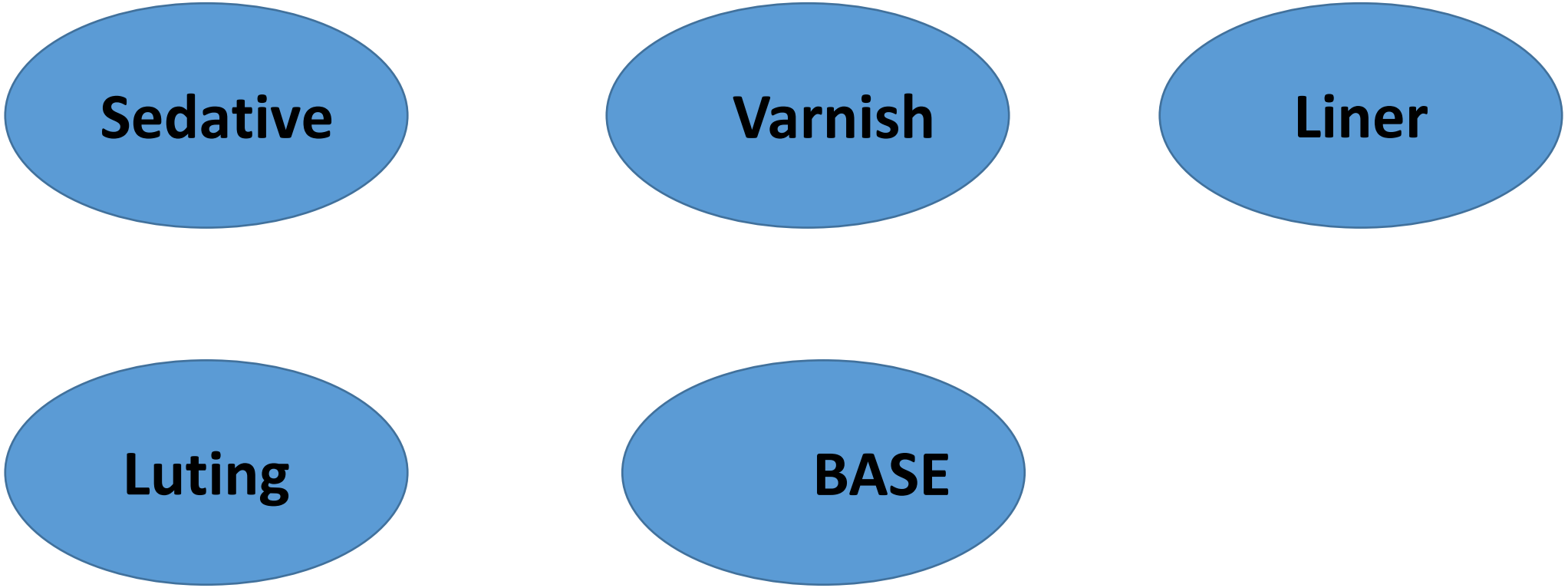
3) Polycarboxlyate cement

4) Glass ionomer cement

B. Free radial addition polymerization:- example is resin cement.

C. Dual cure: They harden by free addition polymerization + acid base reaction example is resin modified glass ionomer cement.

II. According to use



ZINC PHOSPHATE CEMENT

It is the oldest of the current therefore it has wide range of use:

a) Cementation of fixed restorations

b) Cavity base under metallic filling.

c) Temporary filing

Composition:

It is supplied as powder liquid in two separate bottles.

Powder:

1) **ZnO (90%): main ingredient.**

2) **MgO (10%) aid in sintering of the ZnO, i,e reduce melting temperature.**

3) Sio_2: filler.

4) Bi_2O_3: impart smoothness to the freshly mixed cement.

Liquid:

1) H_3PO_4 (50%): main ingredient.

2) H_2O (45%): it controls acid ionization, that affect reaction rate with powder, e.g. increase in water content will increase the ionization which subsequently increase the rate of the reaction.

3) $Al_2 (PO_4)$ and $ZnPO_4$:

a) They reduce the reaction rate, i.e. act as retarders.

b) They stabilize the pH of the acid.

<u>Manufacturing:</u> Using sintering process

a. Ingredients are heated together at 1100º- 1300ºC/ 40-150min

b. Poured

c. Quenched in water

d. Milky white glass powdered by milling

e. Sieved through meshes:

* 45µm for restorative materials

* 20µm for luting materials

Setting reaction:

After mixing of the powder with the liquid, the acid attacks powder and zinc ions are released into the liquid. The result of the reaction is the formation of zinc phosphate amorphous matrix that binds together the unreacted zinc oxide powder and other components of the cement

Zinc oxide + phosphoric acid → amorphous zinc phosphoric + Heat

Microstructure of set cement: a cored structure of residual oxide particles embedded in a cohesive amorphous matrix of zinc phosphoric.

Manipulation:

1) Powder/ liquid ratio: according to manufacturer's directions.

2) Mixing is performed on thick walled cool glass slab {no moisture} using stainless steel spatula. Mixing over a large area.

3) Mixing cements in increments as follows :

*** First: add the small amount of powder into liquid.**

*** To achieve slow neutralization of the liquid.**

*** To control the reaction.**

* **Second: Large amount of powder is added to liquid.**

* **For further saturation of liquid to newly form zinc phosphate.**

- **This step may not effect by heat released from the reaction.**

* **Finally: the small amount of powder is added again to control the optimum consistency.**

Properties:

Although zinc phosphate cements are far from ideal, they are usually regarded as a standard against which to compare newer cements due to:

a) The long persistence of them in clinical performance.

b) Their easy manipulation.

c) Their ideal rheological properties.

I. Working and setting times:

Working time: it is time measured from start of mixing, during which mix viscosity is low enough to flow readily under pressure to form a thin film

Mixing time: (1-2) minutes.

Setting time: **Practically, it is the time at which zinc phosphate cement flash (excess cement) should be removed from margins of restoration.**

Setting Time: (5 – 9) minutes

Factors affecting setting times:

A. Powder/ liquid ratio: ↓ P/L ratio→↑ working and setting times. Not recommended as it impairs the mechanical properties.

B. Rate of powder incorporation: Mixing small quantity of powder into liquid for the first increments, increases working and setting times by reducing heat generated. This method prolong the reducing heat generated. This method prolong the working time without jeopardizing the mechanical properties, therefore it is a recommended method.

C. Spatulation time: ↑ it →↑ working and setting times. Prolonging spatulation time effectively destroys the matrix that was forming, that is, extra time is needed to rebuild the bulk of the bulk of the matrix.

D. Temperature of the mixing slab: It is the **most effective method**. Cooling the slab markedly retard the chemical reaction between the powder and the liquid so matrix formation is retarded. This permits incorporation of optimum amount of powder into the liquid without the mix developing an unduly high viscosity.

II. Consistency and film thickness:

The desired consistency varies according to the purpose for which the cement will be used and it depends upon the P/L ratio

	Thin consistency	Thick consistency
a. Use	Luting agent	Base
b. P/L ratio	Low	High
c. Final viscosity	Fluidy and the mix will sting up from the slab about 2-3 cm, as the spatula is lifted . It's low initial viscosity helps easy flow during restoration seating hence low film thickness.	Putty like with smooth creamy mix that does not follow the spatula.

III. Mechanical properties:

1) It achieves a sufficient degree of compressive strength that allows amalgam condensation. In 10 minutes it attains 50% of its final strength which is after 24 hours.

2) It has low tensile strength because it is brittle material.

3) It has modulus of elasticity similar to that of dentine.

IV. Solubility:

1) They have high solubility rate especially thin mixes.

2) Once they set, their solubility decreases, therefore they must be kept unexposed to oral fluid during their setting.

V. Adhesion to tooth structure:

They are retained to tooth and restorative materials by mechanical interlocking at the interface.

VI. Biocompatibility:

1) **Its acidity is high at the time of cementation. Two minutes after the start of the mixing, the mixing, the pH of zinc phosphate cement is 2.**
2) **The pH then increases gradually but still is only about 5.5 at 24 hours.**

2) The acid can reach the pulp if dentine bridge is 1.5 mm or less. In this case sub-base, e.g$Ca(OH)_2$, should be placed under the zinc phosphate cement to protect the pulp against chemical irritation.

Advantage:

Some advantages of zinc phosphate cement as a cementing medium are:

(1) Inconspicuous appearance.

(2) Speed and ease of usage.

(3) Sufficient flow to form a thin layer for the cementing of closely adapted crowns, fixed partial dentures, and inlays.

(4) Low thermal conductivity beneath a metallic.

Disadvantages:

Some disadvantages of zinc phosphate cement as a cementing medium are:

(1) Low crushing strength .

(2) Slight solubility in mouth fluids.

(3) Opaque material not suitable for surfaces.

(4) Initial pulp irritation

(5) Mechanical bond only

The end