Cavity liners and bases

- **Definitions:**
  - **Varnish:** → Material applied in thin film thickness not exceeding the leakage space at the restoration / tooth interface.
    → Its film thickness is usually 5 - 10 microns.
    → It could be applied to all prepared cavities on both enamel and dentin.
  - **Liner:** → A thin coating (thicker than varnish) that functions mainly to provide a barrier against chemical irritation.
    → It does not function as thermal insulators.
    → It is applied only to dentin.
  - **Base:** → A material that functions as a barrier against chemical, thermal, mechanical and electrical irritation.
    → It is applied only to dentin.

- **Functions and importance:**
  1. **Pulp protection** against: → Thermal irritation → Conductivity of metallic restorations (ex. amalgam) to thermal changes.
     → Chemical irritation → Acids and monomers in non-metallic restorations (ex. Composite) that may lead to pulpal damage and necrosis.
     → Mechanical irritation → The force of condensation.
  2. Some of these materials could improve adaptation and peripheral sealing ability of the cut dentinal tubules.
  3. Some others may enhance deposition of calcific barrier on the pulpal surface of the cut dentinal tubules.
  4. Return the cavity depth in deep cavities to the conventional depth that allows equal distribution of forces.

- **Ideal requirements of liners and bases:**
  1. It must be non-irritant to the pulp.
  2. Must be compatible with the restorative material → i.e. not reacting with it or interfere with its setting reaction.
  3. Strong enough to withstand the force of condensation and mastication.
  4. Reduce the thermal conductivity of metallic restorations.
  5. Improve marginal seal of restorative material and adaptation to cavity walls and margins.
  6. Prevent chemical exchange between the restoration and the tooth.
  7. Reduce galvanic action of certain metallic restorations.
  8. Resist degradation in oral fluids.
  9. Enhance the formation of reparative dentin.
 10. Antibacterial (bactericidal or bacteriostatic).
 11. Easy to be manipulated and applied.
• **Classification and types:**

Refer to the scheme in the power point presentation

**I. Cavity varnish and liners**

1. **Cavity varnish:**

   • **Composition:**
     - Organic copal resin or synthetic gum dissolved in solution of ether, chloroform or acetone.
     - This solution evaporates rapidly after placement on the tooth leaving a thin layer of semi-permeable membrane.
     - The thickness of this layer is 5 – 25 microns depending on the type of the solvent and the number of applications.

   • **Indications:**
     1. Under metallic restorations as it improves: →
        i) Improving adaptation to cavity walls and margins as it blocks the micro-irregularities of walls.
        ii) Reducing marginal leakage of oral fluids at tooth / restoration interface.
        iii) Forming semi-permeable membrane that prevents migration of ions from metallic restoration to the tooth structures that results in:
           a. Chemical irritation to the pulp.
           b. Discoloration of the tooth.
     2. Under acid containing cements as it reduces acid penetration into dentin.

   • **Contra-indications:**
     1. Under glass ionomer and polycarboxylate cements as it prevents or decreases their adhesiveness to tooth structure.
     2. Under composite restorations → the residual monomer will dissolve the varnish →destroying the integrity of the varnish film, which will be of no value to be used.
     3. In moderately deep and deep cavities → as it does not provide thermal insulation.

   • **Application:**
     - The cavity should be dried and cleaned.
     - The varnish is applied with a small cotton pellet that is placed in the solution only once to avoid contamination of the varnish bottle.
     - The varnish is then applied to the cavity as a continuous layer.
     - As the solvent evaporates, it will leave small pits in the film of varnish → so, two or more layers of varnish should be applied.
     - Over thickness should be avoided to prevent spacing between the tooth and restoration that will affect adaptation to cavity walls and margins.
     - Excess varnish is removed from the external tooth surface by the solvent present in the varnish kit.
     - **N.B.** → Varnish is applied to both enamel and dentin.
       → Varnish bottle should be stored in dark, cool place to prevent evaporization of the solvent.
2. Cavity liners:
   a- Calcium hydroxide:

Pharmacological action:
1. Anti-inflammatory → due to alkalinity which neutralizes the acidity of inflammatory medium, giving a chance for repair.
2. Calcifying agent → By perception of calcium ions enhancing repair.
3. Antiseptic.

Advantages:
1. Stimulates reparative dentin formation.
2. Effective against penetration of acids and metallic ions into dentin.
3. Chemically compatible with resinous materials → e.g. Composite.

Disadvantages:
1. Has no obtundant property.
2. Not strong enough to provide reliable support for a restoration under heavy occlusal stresses, so a strong base material should be used to cover it.

Indications:
1. As a sub-base to cover dentin forming the pulpal floor of deep cavities.
2. As capping agent either direct or indirect, to stimulate reparative dentin formation → so, it is the material of choice in deep cavities with suspected pulp exposure.

Contra-indications:
· Under metallic restorations without strong base overlying it (could not withstand the force of condensation and occlusal loading force).

Forms:
2. Paste form: → Calcium hydroxide in ethyl cellulose base.
3. Suspension form: → Calcium hydroxide in distilled water.
   → Calcium hydroxide in solutions of synthetic resins.
   Both are used as cavity liners.

Application:
· Aqueous or non-aqueous suspensions of calcium hydroxide are applied over the prepared cavity floor are in thickness of approximately 0.2 mm.
· This thin layer does not gain sufficient hardness or strength to be used alone as a base → so; it is usually overlaid with zinc phosphate cement.

N.B It is contra-indicated to be applied to enamel where it gives a thick layer that:
   i) Decrease adaptability of the restoration to cavity margins.
   ii) Decrease or block the transfer of fluoride to enamel.

b- Theracal:
refer to power point presentaion
II. Intermediary bases
II.1. Zinc oxide / eugenol cement:

Pharmacological action:
1. Antiseptic action → due to eugenol content and zinc oxide.
2. Anti-inflammatory → due to eugenol.
3. Counter irritant → due to eugenol.
4. Sedative action → due to eugenol.
5. Obtundant action → due to the final product of the mix.
   - It was revealed that → it has a perfect initial stability and sealing which prevent the ingress of saliva, bacteria, and food debris to dentin.
   - This accounts the bland effect and so, eliminates the source of irritation from reaching the dentin.

Disadvantages:
1. Low crushing strength.
2. Slow setting.

Advantages:
1. Its pharmacological actions.
2. Has effective thermal insulating capacity.
3. Capable of blocking the penetration of metallic ions of metallic restorations and acids of cements to dentin.

Indications:
- Usually used as temporary filling material to seal up cavities between visits to bland dentin and pulp.

Contra-indications:
1. As base material ( low crushing strength → i.e. could not withstand the force of condensation).
2. As a sub-base material due to its slow setting which does not enable the immediate application of the overlying base.
3. In cavities prepared to be restored with resinous materials as composite → as the eugenol will retard or prevent its polymerization.
4. As direct pulp capping as it leads to pulp necrosis.

Application:
- A stiff mix is made on the glass slab, in which small cotton strands are added for:
  a) Reinforcing the mix.
  b) Easily handling, insertion and removal.
- The recommended pack has a doughy consistency and then inserted into the excavated tooth.
- The surface is softened with moistened cotton roll and the occlusal relationship is then adjusted.
III. Bases

1. Zinc phosphate cement:

Composition:
1. Powder: → Zinc oxide (9 parts).
   → Magnesium oxide (1 part).
2. Liquid: → Phosphoric acid.
   → Aluminum phosphate.
   → Metalic salts → Acts as buffers to retard reaction.
   → Water → 33 %.

Pulp response:
. The acidity of zinc phosphate cement is high at time of insertion into the tooth.
. The pH is 3.5 after the start of mixing by 3 minutes.
. The pH increased rapidly approaching neutrality in 24 – 48 hours.
. The pH is lower and remains lower for a longer time period when thin mixes are employed.
. The tooth has a very limited buffering effect on pH, so (any damage to the pulp from the acid attack by zinc phosphate cement occurs during the first few hours after insertion).

Advantages:
1. Low thermal conductivity → so, it is a good thermal insulator for the pulp.
2. High strength properties → So, it can withstand condensation and mastication forces.

Disadvantages:
1. Increases dentin permeability due to etching by acids.
2. Irritation due to its acid content → so, cavity varnish or calcium hydroxide as sub-base are used to minimize or neutralize acidity of the cement.

Indications:
1. Replacement of the dentin lost by extensive dental caries to act as:
   a) Thermal insulating base under metallic restorations.
   b) Chemical barrier under silicate and acrylic resin cements.
2. To aid in the mechanical retention of gold and porcelain inlays.

Contra-indications:
. Due to its acidity → It is contra-indicated to be applied in deep cavities without calcium hydroxide sub-base.

Mixing and insertion:

1) Mix on a cool glass slab:
. The setting reaction of zinc phosphate cement is an exothermic reaction, so mixing on a cool glass slab is indicated, as it provides the followings: →
   a) Absorbs the heat of the reaction.
   b) Increases the working time by slowing the reaction.
   c) Permits incorporation of a great amount of powder to the desired mix.
The slab should be cool and dry → i.e. free from any moisture traces as excess water will decrease the setting time.

2) Powder / liquid ratio:
- The consistency of the cement is related to the powder / liquid ratio.
- According to this ratio, there are two types of mixes: →
  a) Luting mix → Thin mix.
  b) Base mix → Viscous mix.
- If the luting mix for seating inlays or crowns is viscous → it will not permit the flow of the cement beneath the casting and the restoration would not be seated properly.
- Volumetric measuring of powder and liquid is important for accurate production of the desired mix.
- With the help of powder dispenser: →
  a) One large and one small cup of the powder are dispensed into the middle area of the slab.
  b) Additional two large cups are dispensed into the upper corner of the slab to be used later.
- The powder of the initial large cup is divided into “6” equal parts.
- 6 – 7 drops of liquid are dispensed to the side of the divided portions.

3) Mixing over a large area:
- Using a long thin bladed st.st. spatula, the first 1/6 of the powder is carried and mixed with the liquid for about 15 seconds and mixed over an area covering at least ½ of the slab.
- Each portion is then spatulated for another 15 seconds, with total spatulation time 90 seconds until inlay consistency mix is achieved.
- Luting inlay mix will have the following character when the mass is gathered and the spatula is laid into it and withdrawn, the cement will string up for 1 – 1.5 inch before breaking.
- Mixing over a large area in such a manner will provide: →
  a) Decrease in exothermic heat of the reaction.
  b) Incorporating a large amount of powder in minimal amount of liquid.

4) Develop a double mix consistency:
- One fifth 1/5 of the mix is placed in the lower corner of the slab and more powder is added in increments until → a heavy putty like consistency mass is developed.
- Properties of this mix are: → 1. Low initial acidity.
  2. Decreased setting time.
  3. Easy carving.

5) Insertion:
- The cavity should be clean and dry.
- Usually tapered plunger is used for insertion of the mix.
- To prevent the cement from sticking to the instrument, the working tip or end of the instrument is immersed in the remaining dry powder.
- The inlay mix is used first for better seal and initial retention, and then heavy mix is placed into the cavity.
• Minimum pressure must be applied to spread the cement into place over the pulpal floor and axial wall only.
• The retentive areas and the margins of the cavity must be free from cement.
• Excess cement can be removed with a sharp excavator and the floor is smoothened carefully with an inverted cone bur.
• Excessive vibration from the bur may loosen or fracture the cement.
• Ample room must be left for adequate thickness and bulk of the restoration specially amalgam.
• N.B.: Dryness of the cavity with alcohol should be avoided as it increases the chance of the acid to be absorbed into dentin with possible pulp damage. Cavity varnish could be applied before the cement to reduce acid penetration into the pulp.

2. **Reinforced zinc oxide / eugenol cement:**
   - It is a modified zinc oxide / eugenol cement, where additives are added to both powder and liquid to overcome its disadvantages.
   - The main **disadvantages** of Zn/E cement are:
     1. Low strength.
     2. Prolonged setting time.

**Composition:**
1. Powder: → Zinc oxide and zinc acetate.
   → 10 – 20% resins → increase strength from 2000 to 6000 PSI
   e.g. Polystyrene, Polycarbonate.
   → Alumina → For reinforcement.
2. Liquid: → 62.5% Ethoxy benzoic acid (EBA) → provides higher strength up to 9000 PSI.
   → 37.5% Eugenol.

**Indications:**
As sedative and obtundant.

**Advantages:**
1. Sedative and obtundant.
2. Thermal insulator → due to its low thermal conductivity.
3. Chemical insulating barrier.

3. **Zinc polycarboxylate cement:**

**Composition:**
   → Magnesium oxide.
   → Small amounts of calcium hydroxide.
   → Fluoride.
2. Liquid: → Polyacrylic acid.
**Advantages:**
1. Has a higher degree of chemical adhesion to tooth structure than any other cement.
2. Produces minimal pulp irritation as it is less acidic than zinc phosphate cement.
3. Has higher tensile strength than zinc phosphate cement.

**Disadvantages:**
1. Twice soluble than zinc phosphate cement.
2. Lower compressive strength than zinc phosphate cement.

4. **Glass ionomer cement:**
   *Refer to Lecture...*

**Remember that:**
1. The only material that could be applied to enamel and dentin is Varnish.
2. Materials used under composite:
   a) Calcium hydroxide.
   b) Glass ionomer.
3. Materials contra-indicated under composite:
   a) Cavity varnish and liners.
   b) Eugenol containing material: $\rightarrow$ ZnO/E cement.
   $\rightarrow$ Reinforced ZnO/E.
4. Materials not recommended to be used under composite as it could affect the final color of composite restoration:
   a) Zinc phosphate cement.
   b) Zinc polycarboxylate cement.
5. Adhesive materials:
   a) Polycarboxylate cement.
   b) Glass ionomer cement.
6. Anticariogenic materials: $\rightarrow$ Only glass ionomer.
7. Polyacrylic acid based materials:
   a) Polycarboxylate cement.
   b) Glass ionomer cement.
8. Materials having pharmacological action:
   a) Calcium hydroxide.
   b) Zinc oxide/ Eugenol cement.