## Importance of Remaining Dentin Thickness (RDT)

**Definition:**

▪ Remaining dentin thickness (RDT) is the dentin present between the floor of the tooth preparation and pulp chamber.

Dentin is the best insulator and protector to pulp.

## Clinical Rule

➡ The remaining dentin under the cavity preparation should be at least **2 mm thick**

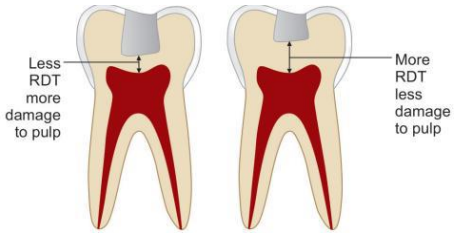
➡ To guarantee protection of the pulp

➡ Otherwise → a thick liner or a base is used to augment dentin to the proper thickness range

⚠ As the remaining dentin thickness decreases → the pulp response increases.

## Effect of Toxic Substances vs Remaining Dentin Thickness

| Remaining dentin thickness | Effect of toxic substance |
|---|---|
| 0.5 mm | 25% |
| 1 mm | 10% |
| 2 mm | Minimal or nil |




## Cavity Liners and Insulating Bases

Definition:

Materials placed between dentin (sometimes pulp) and restorative material

➡ To provide pulpal protection or control pulpal response.

## Function of the Liner or Base

### A-Pulpal protection (preserving health & vitality)

1. Chemical protection
2. Electrical protection
3. Mechanical protection
4. Biological protection
5. Thermal protection
6. Pulp medication

### B-Increase adaptability of restoration or sealing

### C-Strengthening of tooth structure

# Ideal Requirements for Intermediary Materials

## Biological Requirements (biological protection)

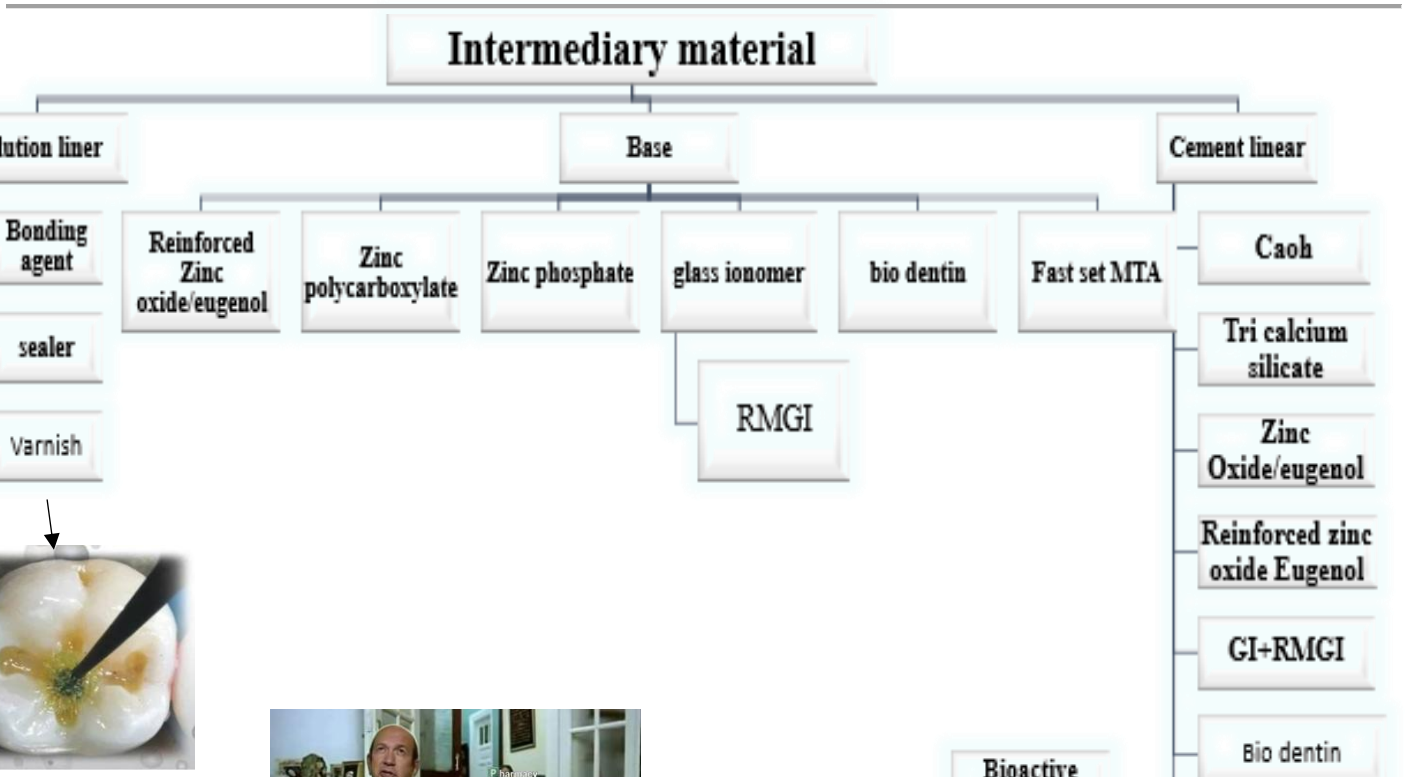
1. It should provide no further irritation and be biocompatible with pulp–dentin organ
   - → Stimulate reparative dentin formation
2. The material should provide a sedative and palliative action to the pulp
3. It should improve the marginal sealing and adaptation to the cavity walls

## Physical & Mechanical Requirements

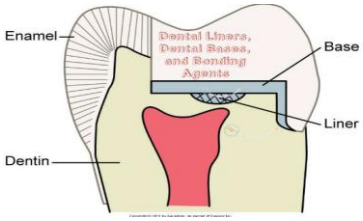
4. Possess thermal and electrical insulating capacity
   - → (Thermal protection)
5. Have sufficient strength to resist fracture or distortion
   - → Under condensation of permanent restoration
   - → And subsequent masticatory forces (mechanical protection)

## Clinical Requirements

6. Compatible with overlying restorative material and other base materials
7. Resist degradation in oral fluids
8. Adequate workability and easy to apply






# Liner vs Base

## Dental Liner

- A thin protective layer (< 1 mm)
- Placed especially over exposed dentin
- Before placing final restorative material
- For therapeutic and biological aims

## Dental Base

- A thicker layer (1.5 – 2 mm)
- Placed beneath a restoration
- Functions:
  - Mechanical support
  - Thermal insulation
  - Pulpal protection

# Cavity Varnish

## Composition

- Liquid composed of:
  - 10% natural gum (copal or rosin) OR synthetic resin
  - Dissolved in 90% organic solvent (ether, acetone, or chloroform)

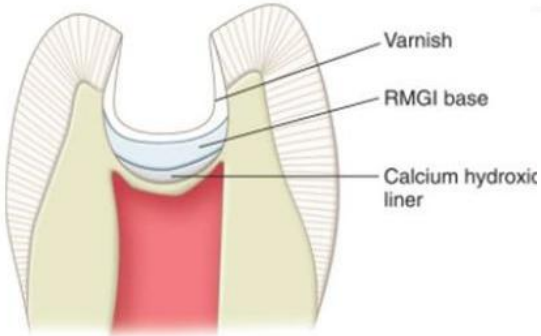
## Functions

- Provides a thin protective coating over dentin
- Reduces microleakage
- Prevents penetration of irritants from restorative materials

## Limitations

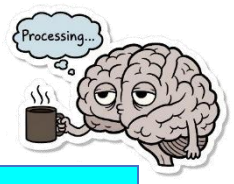
- ✗ Soluble in oral fluids → protection is temporary
- ✗ Not suitable under glass ionomer (interferes with adhesion)
- ✗ Not suitable under composite restorations (interferes with bonding)

- Primarily used under amalgam in:
  - Shallow to moderate cavities
  - Temporary restorations



## Application Steps of Varnish (Clinical Steps)

- Use a small cotton pellet or disposable applicator dipped in varnish
- Apply minimum **two coatings** over cavity walls and floor
- Ensure complete coverage of exposed dentin
- Allow first coat to dry
- Apply second coat to fill pinholes and voids
- Allow solvent to evaporate naturally
- Thin resin film remains as protective barrier against irritants and microleakage




## Dentin Sealer vs Cavity Varnish

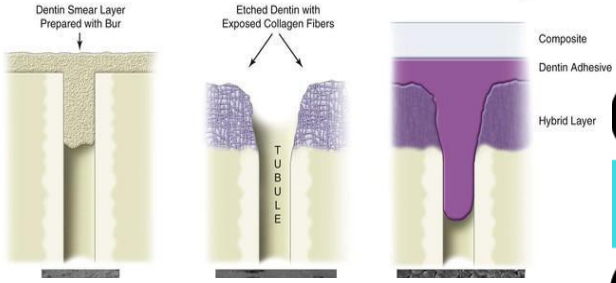
| Feature | Dentin Sealer | Cavity Varnish |
|---|---|---|
| **Composition** | Resin-based or chemical agents (glutaraldehyde, potassium oxalate, bonding agents) | Natural or synthetic resins in volatile solvents |
| **Mechanism** | Penetrates dentinal tubules → seals chemically/mechanically | Forms thin resin film after solvent evaporation |
| **Function** | Seals tubules,<br>Reduces fluid movement, decreases Hypersensitivity,<br>Provides long-term protection | Temporary barrier,<br>Reduces microleakage,<br>Protects pulp (esp. amalgam) |
| **Durability** | More durable, less soluble | Soluble in oral fluids, short-lived |
| **Use** | Common under composites and exposed dentin (desensitizing agent) | Traditionally under amalgam |
| **Limitation** | Technique sensitive (etching/bonding protocol) | Not compatible with composites (blocks resin bonding) |



## Dentin Bonding Agents (DBAs)

**Definition :** Resin-based systems designed to:


- Dissolve or penetrate the smear layer
- Bond micromechanically to tooth structure




### Polymerization

- Usually cured with visible light

## 🎯 Uses of Bonding Agents

- Bonding resin composites to enamel and dentin
- Bonded amalgam restorations (reduce microleakage)
- Indirect restorations (inlays, veneers) → bond restoration to tooth
- Sealing dentinal tubules → reduces sensitivity & microleakage

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# 🧪 Calcium Hydroxide ($Ca(OH)_2$) Liners

## 📜 Forms

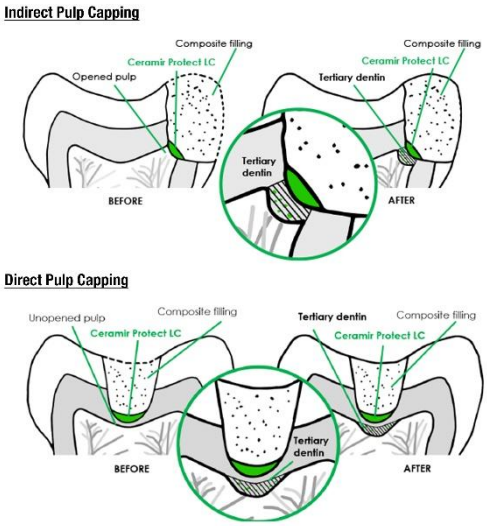
- Powder & liquid
- Suspension
- Paste–paste system (base & catalyst)
- One paste system


## 🧬 Composition

- Acidic paste → alkyl salicylate + inert fillers (radiopacity)
- Basic paste → calcium hydroxide

## ⚙️ Properties & Function

- ✔ Releases calcium and hydroxyl ions
- ➡ Stimulates reparative dentin formation
- ✔ Very high pH (11–12.5)
- ➡ Antibacterial properties
- ➡ Stimulates reparative dentin
- ✔ Setting reaction: Acid–base reaction




## ⚠️ Disadvantages

- ✖ Weak strength
- ✖ Solubility
- ✖ Poor adhesion
- ✖ Dentin bridge often porous or incomplete → bacterial leakage

## Application of $Ca(OH)_2$ (Step-by-Step)

### Clinical Steps

| Step | Description |
|---|---|
| 1 Cavity Preparation | ➡ Remove caries, shape cavity, clean and dry area |
| 2 Isolation | ➡ Use cotton rolls or rubber dam to prevent contamination |
| 3 Mixing | ➡ Paste form: mix base + catalyst until homogeneous ➡ Light-cured: ready to apply |
| 4 Placement | ➡ Apply thin layer (~0.5 mm) over deepest dentin or pulp exposure ➡ Using ball applicator (CaOH applicator) |
| 5 Setting | ➡ Allow self-cure or light-cure حسب نوع المنتج |
| 6 Covering | ➡ Place protective base (e.g., glass ionomer) over liner |
| 7 Restoration | ➡ Complete with amalgam, composite, or other restorative material |

# Zinc Oxide Eugenol (ZOE) & Reinforced ZOE (RZOE)

## Composition


- Powder: Zinc oxide
- Liquid: 85% eugenol (oil of clove)

**Additives:**

- **Salts** (e.g., zinc succinate) → accelerate setting
- **Polymers** → increase strength & reduce solubility
- **Fillers** (silica, alumina) → increase strength

### Reinforced ZOE (RZOE):

Modified formulation where part of eugenol is replaced with ethoxy benzoic

## Setting Reaction

➡ Chelation reaction:
Eugenol + ZnO → Zinc Eugenolate + Water

## Biological Effects

- ✔ Palliative, sedative and obtundant action on pulp (low concentration)
- ✔ Antiseptic and anti-inflammatory effect

## 🎯 Clinical Properties

- Can be placed in moderately deep cavities (RDT ≈ 1 mm)
- Excellent thermal insulator (even at 0.25 mm thickness)
- Good electrical insulator
- Good sealing ability

## ⚠️ Disadvantages

❌ Low strength
❌ Not rigid enough to be used as a strong base
❌ Still inferior in strength compared to other cements

## 📌 Indications

1️⃣ As a liner in moderately deep cavities
2️⃣ Temporary filling material
3️⃣ Temporary cementation
4️⃣ As a base when biological consideration > mechanical

## 🚫 Contraindications

❌ Very deep cavities (dentin bridge ≤ 0.5 mm)
❌ Direct pulp capping (irritates pulp, no dentin bridge formation)
❌ With composite resin (eugenol interferes with polymerization)
❌ With glass ionomer & polycarboxylate (reduces bonding ability)

# 🧪 Glass Ionomer Cement (GIC)

## ⭐ Advantages

✔️ Excellent sealing ability (chemical adhesion to tooth)
✔️ Anticariogenic (fluoride release)
✔️ Biocompatible with pulp–dentin organ
✔️ Provides thermal, chemical & mechanical protection
✔️ Proper sealing of dentinal tubules
✔️ Excellent dentin substitute


⚠️ If RDT < 1 mm → $Ca(OH)_2$ liner is required first.

## 💎 (Advantages of RMGI) RMGI over Conventional GIC

- Flexible working time
- Improved strength and wear resistance
- Ease of handling
  - ⚠️ Conventional GIC has higher initial fluoride release (first 24 hrs burst)

**Indications:**

1-sandwich technique

2-liner/base

# 🧴 Theracal LC

## 📌 Definition

Resin-modified calcium silicate pulp protectant / liner.

## 🌟 Key Features

- ✔ Provides calcific barrier protecting pulp–dentin complex
- ✔ Light-cured (polymerization reaction)
- ✔ Allows immediate placement of permanent restoration (single sitting)
- ✔ Hydrophilic resin → stable and durable liner/base
- ✔ Alkaline pH (≈10.66 at 3 hours)

## 🎯 Indications

- Indirect pulp capping
- Under Class I & Class II composite restorations
- Under other base materials
- Used as liner or base

## ★ Advantages

1. Helps reparative dentin formation
2. Low solubility (vs $Ca(OH)_2$, Biodentine, MTA)
3. Remineralizing agent
4. Better bond strength (vs CaOH & Biodentine)
5. Antibacterial property

**N.B**

One problem with resin-based materials is that unreacted methacrylate groups can become attached to a freshly placed compositeresin restoration. The composite shrinks during its setting reaction, which can pull the calcium hydroxide material away from the tooth, leaving a void.

It is preferred to use in the in direct pulp caping as its resin may cause pulp irritation if direct contact with the pulp

# Flowable Composite as Liner

## Characteristics

- Low viscosity
- Increased elasticity
- High wettability
- Better marginal adaptation with composite


## Disadvantages:

- Higher polymerization shrinkage
- Lower mechanical properties (due to low filler)

## Clinical Use

- Used as very thin liner (~0.5 mm) on cavity floor
- Applied as single bulk layer (up to 4 mm)
- Followed by 2 mm composite restoration layer

# Bio-dentine (Bioactive Dentin Substitute)

## Composition

**Powder:**

- Tricalcium silicate
- Dicalcium silicate
- Calcium carbonate & oxide (filler)
- Zirconium oxide (radiopacifier)

**Liquid:**

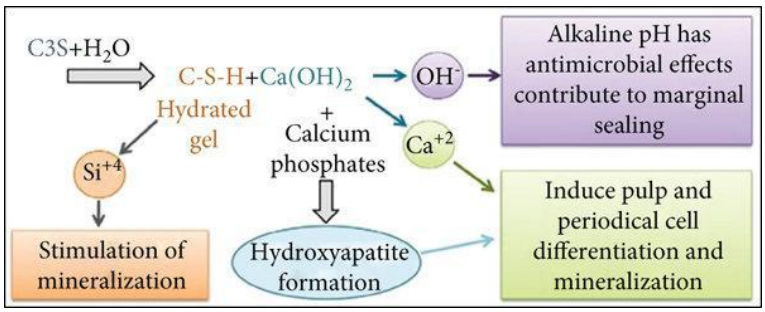
- Calcium chloride (accelerator)
- Hydrosoluble polymer + water

•Preservation of pulp vitality.

•Ultimate dentin substitute.

## Setting Reaction

- Mixing time: 30 sec in amalgamator
- $C_3S + H_2O \rightarrow CSH\ gel + Ca(OH)_2$




## Properties of Biodentine

### 2 Adhesion

- Crystal growth within dentinal tubules
- Provides long-lasting seal
- Ion exchange with dentine
- Creates chemical interaction at tooth–material interface

### 3 Density and Porosity

- Hydrosol polymers decrease the amount of water
- Improve density
- Better mechanical properties

### 4 Radiopacity

- Due to zirconium oxide
- Easily identified in radiographs

### 5 Compressive Strength

- More than **200 MPa** at first 24 hours
- Improves up to **300 MPa within one month**
- Approaching natural dentine strength (≈297 MPa)

### 6 Biodentine–Tooth Interface

- Precipitation of apatite-like Ca-phosphate crystals
- High resistance to:
  - Acid erosion
  - Microleakage

### 7 Ion Release

- Ability to release **Ca and OH ions**

## 8 Antibacterial Properties

- $Ca(OH)_2$ ions released
- Increase pH to approximately **12**
- Creates antibacterial environment

## 9 Stability in Oral Fluids

- Not as stable as composite restorations
- More stable than other comparable materials

## Biological & Clinical Advantages

- Minimal post-operative hypersensitivity (Minimal P.O.H)
- High biocompatibility
- Low risk of pulp tissue reaction
- Bioactive properties
- Stimulates secondary dentin formation (lasts for about 3 months)
- Promotes pulp healing
- Suitable for deep cavities
- Used in pulp capping (Direct & Indirect)
- Prevention of clinical failures

## Structural & Sealing Advantages

- Mineral tags formation in dentinal tubules (DT)
- High dimensional stability
- Low risk of bacterial percolation
- Remineralization of interfacial dentin
- No conditioning or bonding required
- Natural micromechanical anchorage in dentinal tubules
- Ion exchange chemical bonding

## Clinical Efficiency

- Full restoration in one session
- Low chair time

كل ما يقل الـ RDT → لازم تزود الحماية بـ Liner أو Base

- Deep cavity → $Ca(OH)_2$ + Base (GIC/RMGI)
- Moderate cavity → ZOE أو GIC
- Composite restorations → Bonding agent + Flowable liner
- Very deep / pulp protection → Biodentine أو Theracal LC.