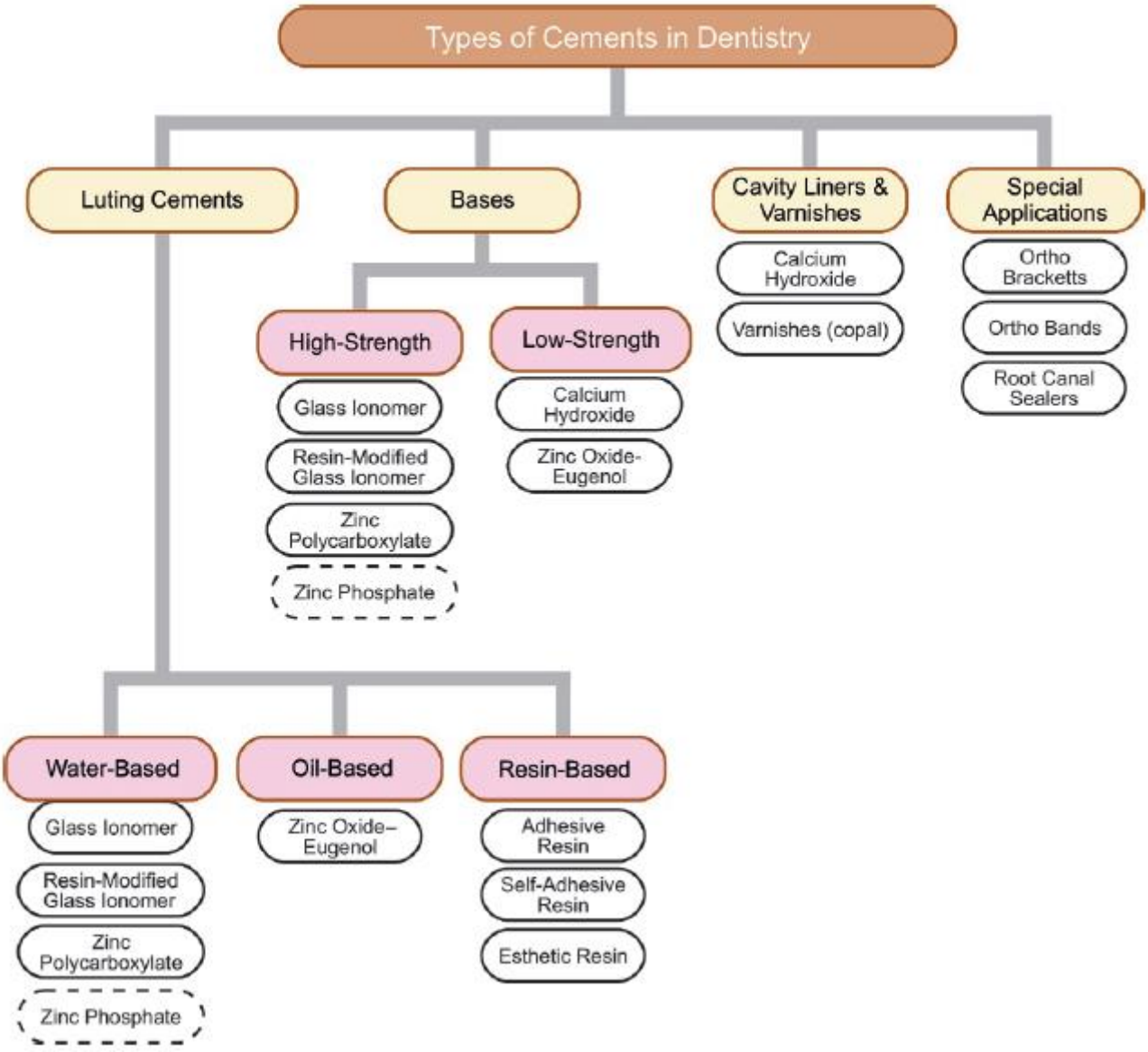
DENTAL CEMENTS

CLASSIFICATION



Based on major composition (Craig)	**Based on type of bonding (O' Brien)**	**Based on setting reaction (Wilson)**
•Zinc Phosphate cement •Zinc oxide eugenol cement •Zinc polyacrylate cement •Glass ionomer cement •Resin cement	•Phophate •Polycarboxylate •Phenolate •Resin •Resin modified GIC	•Acid-base cements •Polymerized cements

CAVITY VARNISHES

A varnish acts as a protective layer between prepared tooth and restoration.

Uses:
Seals the dentinal tubules and pulp from irritants of either restoration or luting agent, Prevents marginal leakage

Composition:
Natural gums (Copal rosins, synthetic resins) dispersed in solvents (Alcohol, chloroform)

Application:
Applied as two or three layers on the surface of prepared tooth (1-40μm) with a break of 5 to 15 seconds

Contraindicated:
In adhesive bonding agents (GIC, composites)

Examples:
Flouride varnish, desensitizers, tooth whitening varnishes

CAVITY LINERS

Cavity liners are thin (0.5mm) protective barriers with therapeutic effects and no mechanical strength and thermal insulating properties

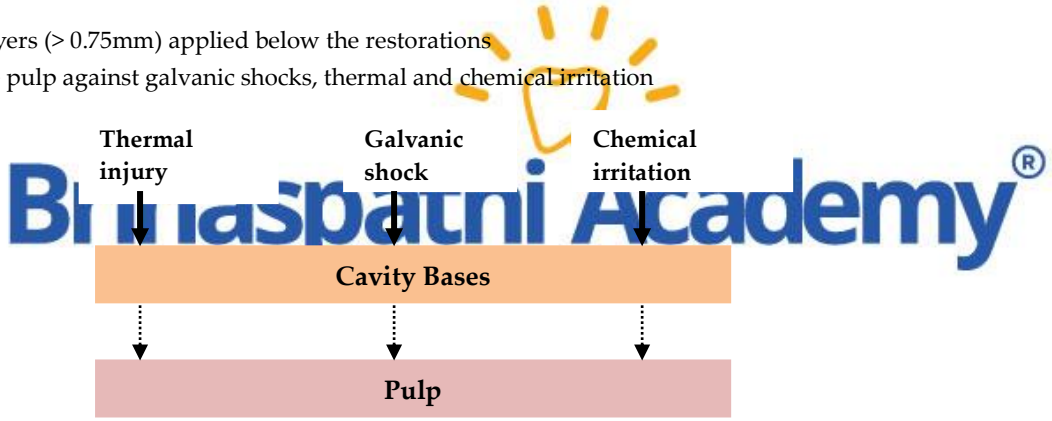
Uses: Prevents marginal leakage, secondary dentin formation, neutralizing acids of luting agents

Examples: Calcium hydroxide (for direct & indirect pulp capping), Zinc oxide eugenol (Low viscous), Glass ionomer cement, MTA.

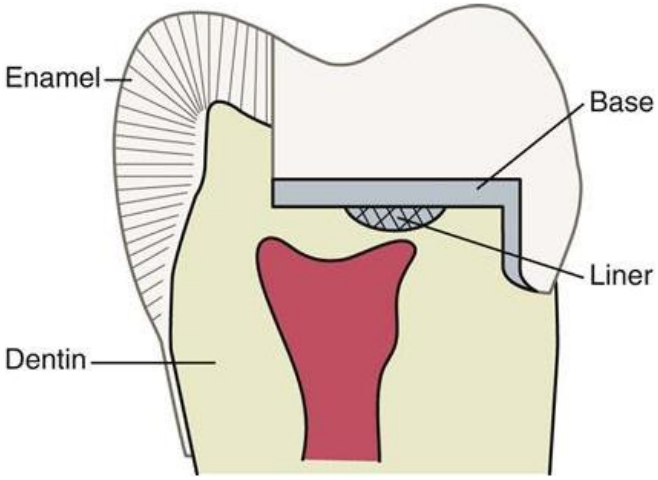
CAVITY BASES

Bases are thick layers (> 0.75mm) applied below the restorations

Uses: Protects the pulp against galvanic shocks, thermal and chemical irritation



Examples: Calcium hydroxide, Zinc phosphate, Zinc oxide eugenol , Polycarboxylate, Glass ionomer cements



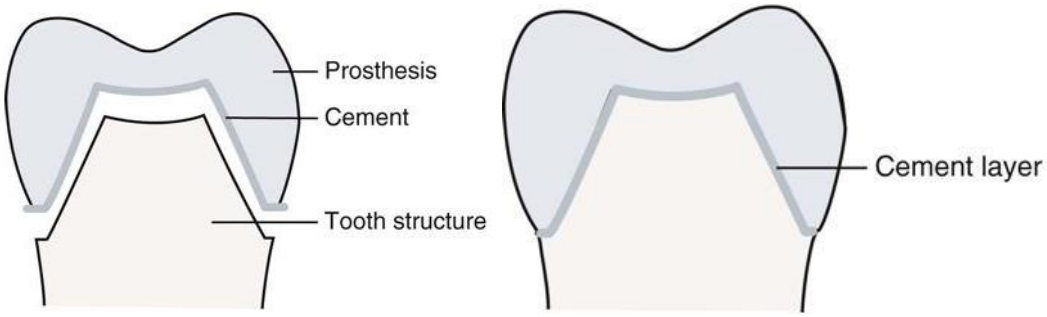
Comparison of cement bases with other materials

Material	Thermal Conductivity (W/m·K)
Zinc phosphate cement (dry)	1.26
Zinc phosphate cement (wet)	1.63
Zinc oxide–eugenol	1.67
Corkboard	0.04
Gypsum plaster board	0.17
Portland cement	0.29
Glass	1.01
Zirconia ceramic	1.7
Ice	2.18
Stainless steel	15.9
Alumina	30
Pure gold	297

LUTING CEMENTS

Ideal characteristics of luting agents:

- Should be biocompatible and protect the dentine and pulpal tissues of the teeth.
- Sealing at the interface of tooth or restoration should be perfect to avoid bacterial entry.
- Adequate bonding (physical, chemical, micromechanical etc.,).
- Have higher strength, fracture and wear resistance.
- Good handling properties
- Radio opaque (to assist in diagnosis)
- Film thickness should be less to allow placement of restoration
- Solubility should be less to avoid disintegration of cement
- Good esthetics



SILICATES

Composition	Setting reaction	Advantages	Disadvantages
•Powder: Silica (SiO_2), Alumina (Al_2O_3), NaF, CaF_2, Flux , CaO •Liquid: Phosphoric acid, Buffer salts, $AlPO_4$, $ZnPO_4$, Water	•Type: Acid base reaction with release of flouride ions •Powder/Liquid ratio: 1.6gm/ 4ml	•Prevents secondary caries, proximarl caries due to flouride release	•Highly soluble leading to loss of cement •Marginal leakage •Pulpal irritation

ZINC SILICOPHOSPHATE

Applications	Classification	Composition	Setting reaction
•Luting agent for restorations & orthodontic appliance •Interim restoration •To make dies	•Type I: Cementation •Type II: Interim filling material •Type III: Both Type I & Type II	•Powder: Glass silicate, Zinc oxide, Magnesium oxide •Liquid: Phosphoric acid, Water, Zn & Al salts	•Type: Acid base reaction with release of flouride ions •Setting time: 3 - 15 mins

Physical & Biological properties

Silicates	
24 hr Compressive strength	**108 MPa**
24 hr Diametral tensile strength	3.5 MPa (Weak)
Hardness	70 KHN (dentine)
Solubility in water	0.7 wt% (High)
pH	Insertion < 3, 1 Month < 7

Zinc silicophosphate	
24 hr Compressive strength	**165 MPa**
Solubility in water	0.9 wt% (High)
Film thickness	25 μm

ZINC OXIDE EUGENOL

Classification	Composition	Setting reaction:	Manipulation
•Type I: Temp cement (40μm), Luting agent •Type II: Long term cement (25μm), Luting agent •Type III: Temp restoration •Type IV: Interim restoration	•Powder: ZnO (60%), Rosin, Zinc stearate & Zinc acetate (Accelerates and strengthens) •Liquid: Eugenol (85%), Olive oil	•Type: Acid base reaction (Chelation) •$ZnO + H_2O \rightarrow Zn(OH)_2$ •$Zn(OH)_2$ + Eugenol (E) • $\rightarrow ZnE_2 + 2H_2O$ •Water is the byproduct	•Available either in powder /Liquid or Pastes •Mixed on a glass slab with a spatula until even consistency is achieved •Mixing time: 30 - 60 sec •Setting time: 4 - 10 min

Advantages:

- Least irritating among the dental materials
- Excellent seal
- Therapeutic effect on pulp

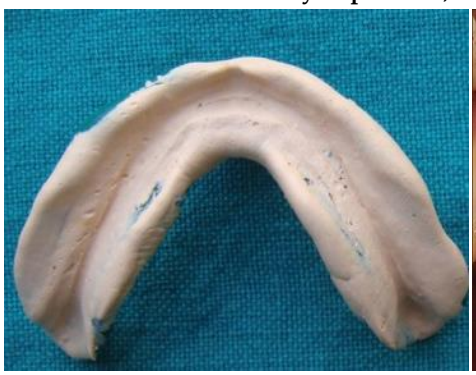
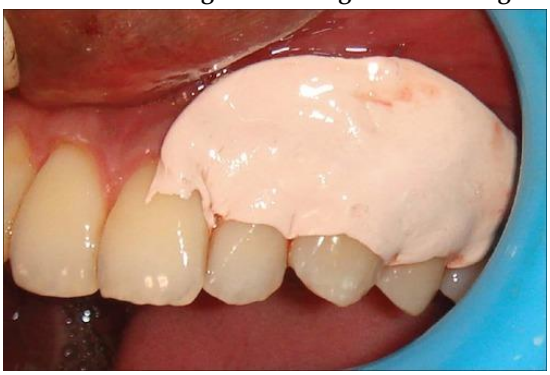
Disadvantages:

- Low strength and abrasion resistance
- Solubility in oral fluids
- Little anticariogenic action

Uses: Used for

- Temporary & Permanent cement
- Temporary & Interim restoration
- Cavity base & Liner
- Root canal sealing agent
- Periodontal dressing
- Impression material
- Bite registration

Secondary impression, Periodontal dressing and Bite registration suing Zinc oxide eugenol


Characteristic Properties

ZOE (Type I)		ZOE-EBA (Type II)		ZOE plus polymer (Type II)	
Setting time	4 - 10 mins	Setting time	9.5 minutes	Setting time	6 - 10 mins
Maximum film thickness	25 µm	Maximum film thickness	25 µm	Maximum film thickness	32 µm
24 hr Compressive strength	6 - 28 MPa	24 hr Compressive strength	55 MPa	24 hr Compressive strength	48 MPa
24 hr Diametral tensile strength	-	24 hr Diametral tensile strength	4.1 MPa	24 hr Diametral tensile strength	4.1 MPa
Elastic Modulus	-	Elastic Modulus	5.0 GPa	Elastic Modulus	2.5 GPa
Solubility in water	0.04 wt%	Solubility in water	0.05 wt%	Solubility in water	0.08 wt%

Modifications

ZOE reinforced with alumina (Super EBA)

- Powder: ZnO (30%), Alumina (30%)
- Liquid: Ortho EBA(Ethoxy benzoic acid), Eugenol
- Compressive strength: 55 Mpa
- Working time: Long
- Setting time: 9.5 min

ZOE reinforced with Polymer

- Powder: ZnO (80%), Polymethylmethacrylate (20%)
- Liquid: Eugenol, Acetic acid, Thymol
- Compressive strength: 48 Mpa
- Working time: Long
- Setting time: 6-10 min
- Good abrasion resistance

ZOE reinforced with Resin

- Powder: ZnO (88%), Rosin (10%)
- Liquid: Polystyrene (10%), Eugenol (90%)
- Compressive strength: 40 Mpa
- Working time: Long

Cements with vanillate esters

- Pwder: ZnO
- Liquid: Ortho EBA, Hexyl vanillate
- Higher strength, lesser solubility

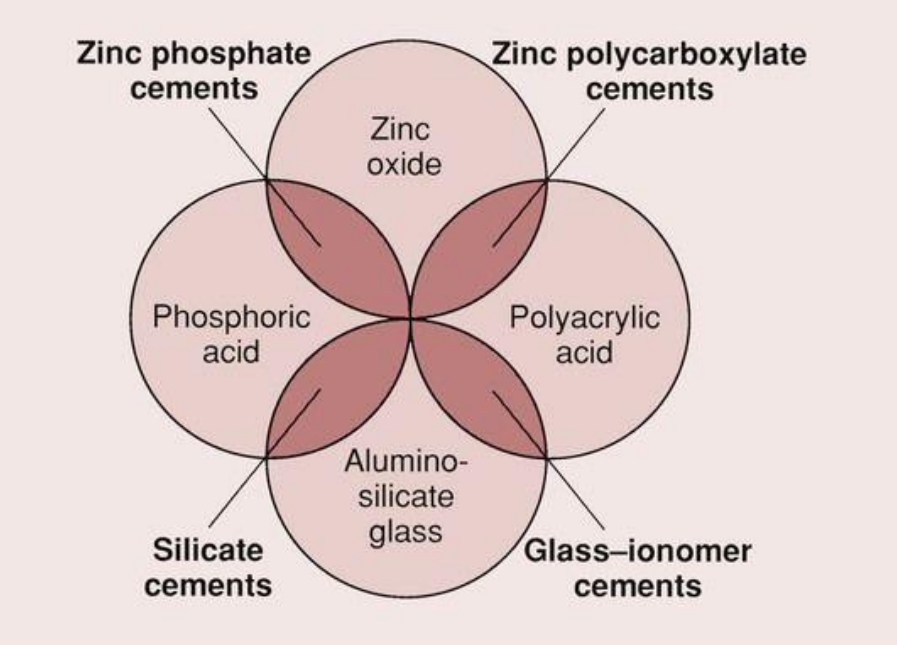
ZOE-Fast setting & Non setting ZOE

- Fast setting is inititated by adding zinc acetate.
- Additives can be adding to reduce the setting time

Non eugenol ZOE

- Zinc oxide, oils (Aromatics, olive),Petroleum jelly, beeswax, oleinic acid.

	ZINC PHOSPHATE CEMENT	POLYCARBOXYLATE CEMENT	GLASS IONOMER CEMENT
Classification	Oldest **gold standard** cement Also known as crown & bridge cement Type I: As Luting agent (25 μ) Type II: For bases & restorations (40 μ)	It is the first cement to bond chemically to teeth	Also called as Polyalkynoate cements Acc to Philips: *Type I:* Luting *Type II:* Restorative *Type III:* Liner & Base
Uses	Luting agent - restorations, orthodontic applainces Interim restoration, bases	As Permanent cement for restorations, FPD's, inlays & onlays Orthodontic c ementation. high strength base	Esthetic restorations, luting, core build up, lamination technique, orthodontic bracket placements
Composition	**Powder:** ZnO (90%), MgO (8%), Oxides of bismuth, calcium, barium (0.2%), Silica **Liquid:** Phosphoric acid(38.2%), water (36%), Alumina (16%), Al & Zn (buffers)	**Powder:** ZnO (major), MgO/ SnO (modifier), BiO, Alumina, SnF **Liquid:** Polyacrylic acid (PAA), itaconic acid, tricarboxylic acid, maleic acid	**Powder:** Silica (35-50%), Alumina (20-30%), Aluminium ,calcium and sodium fluoride, Alpo4, Barium(traces) **Liquid:** Polyacrylic acid (45%), Itaconic acid, maleic acid, tricarboxylic acid, tartic acid, water(50%)
Setting reaction	$ZnO + H_3PO_4 \rightarrow Zn_3(PO_4)_2$ (Zn Al Phosphate gel) + H_2O Water is the main component for this reaction W/P ratio: 1.4 gm/0.5 ml Manipulated on a cool glass slab to improve WT & ST	PAA + Glass particles (via carboxyl group) → Polycarboxylate cement	**Decomposition** of glass in acids **Release** of Ca, Fl, Al, Na ions **Migration** of ions into aqueous stage of cement **Gelation** of acid and the ions **Hardening** for 24hrs with the cross link of ions in acid **Maturation** after 24hrs



Modifications of Glass ionomer cement (GIC)

1. METAL MODIFIED GIC:

- Developed to improve the fracture toughness of GIC

Miracle mix

Mixture of silver amalgam alloys with Glass ionomer powder

Disadvantage: Inferior to the properties of amalgam

Adhesion is not strong with alloy particles

Cermet

Substituted by **Ag-Pd alloy** which allows chelation with polyacrlic acid

Advantages: Adhesion, anticariogenic, wear resistnace

Disadvantages: Poor esthetics, discoloration of tooth, roughed surface, decreased working and setting time

Indications: Core build up, class I restorations, lining

Contraindication: Anetrior teeth, High occlusal loading areas

2. RESIN - MODIFIED GIC/ HYBRID IONOMER CEMENT

Composition	Chemistry	Clinical applications	Advanatgaes & Disadvantages
•Powder: Conventional powder and camphoroquinone for light or chemical activation •Liquid of GIC is modified with methylmethacrylate and HEMA	•Acid base reaction along with polymerization •Rate of reaction is less because of reduced water content	•Pit & fissure sealants •Class I, II, V restorations •Core build ups •Liners and bases •Orthodontic bracket placements	•Advanatges: Improved WT, ST, Strength, adhesive property, anticariogenic, reduced sensitivity to water •Disadvantages: Marginal leakage due to shrinkage

3. CALCIUM ALUMINATE GIC

- It is a product of combination of GIC with calcium aluminate (Al_2O_3 : CaO = 1 : 1)
- Used to lute fixed prosthesis

Composition	Properties
Powder: Calcium aluminate Tartaric acid Polyacrylic acid St - Fl - Al - glass **Liquid:** Water (99.6%)	Working time - 2 Mins Setting time - 5 Mins Film thickness - 15 +/- 4 µm Setting expansion - 0.4 %

Additives	

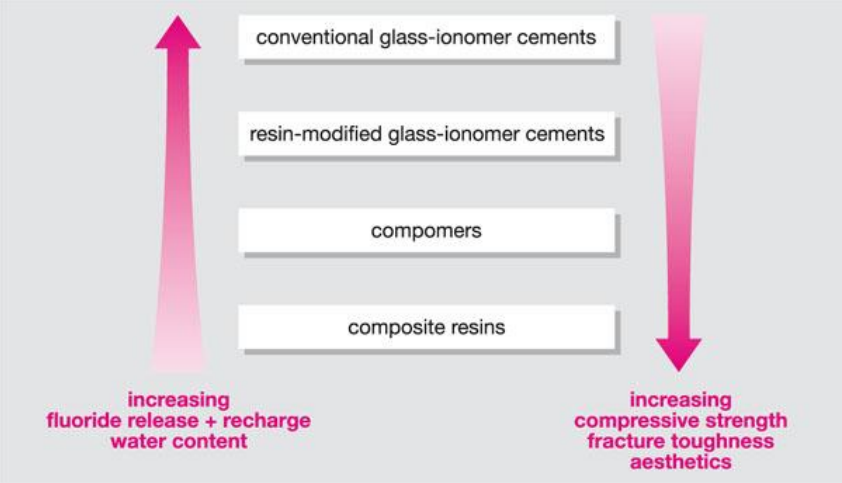
4. COMPOMER/ POLYACID MODIFIED COMPOSITE RESIN

- It is a modification of GIC into water free polyacrylic acid along with added initiators
- Developed to attain fluoride releasing capacity along with composite resin properties

Uses:

- Pit & fissure sealants
- Restorations for primary teeth, Class III, V lesions
- Core build ups
- Liners & bases
- Cervical abrasion
- Retrograde filling materials

Composition & Setting	Properties	Advanatages	Contraindications
•Powder: St - Al - Fluorosilicate glass, Oxides of metals, Initiators •Liquid: Methacrylates and water •For restorations - need dentin bonding agent •For luting - self adhesive	•Micromechanical adhesion •minimal flouride release •Properties: GIC > Compomer < Composite	•Better adapatation to tooth •Esthetics •WT greater than RMGIC	•Cannot be given for Class II, IV cavities •Lost tooth surface areas •As luting agent under Full coverage restorations



RESIN CEMENTS

They are flowable consistency composites with low viscosity used for Cementation of prosthesis, restoration, orthodontic brackets

Classification: consists of filled & unfilled matrix

Class I: Self cure

Class II: Dual cure
Class III: Light cure

Composition

Chemical cure	Dual cure	Light cure
Powder: Resin (PMMA), Inorganic fillers **Liquid:** Methylmethacrylate, teritiary amines, organosilanes	**Base paste:** PMMA, fillers **Catalyst:** Methylmethacrylate, fillers, initiators	Available in one paste system with methylmethacrylate monomers like HEMA, 4META etc

INDICATIONS & CONTRAINDICATIONS

Type of prosthesis	Type of Luting Agent				
	Zinc Phosphate	Zinc Polycarboxylate	Glass Ionomer	RMGIC	Resin Cement
Cast crown, PFM crown.	Indicated	Indicated	Indicated	Indicated	Indicated
Pressed ceramic crown, ceramic inlay, ceramic veneer, resin bonded FPD	Contra-indicated	Contra-indicated	Contra-indicated	Contra-indicated	Indicated
Patient with history of post-treatment sensitivity	-	Indicated	-	-	Contra-indicated
Crown or FPD with poor retention	Contra-indicated	Contra-indicated	Contra-indicated	Contra-indicated	Indicated
Cast post and core	Indicated	Contra-indicated	Indicated	Indicated	Indicated

PROPERTIES

Luting agent	Biological (Effect on Pulp)	Chemical			Rheological			Physical & Mechanical		
		pH		Solubility in H_2O at 24 hrs.	WT (min)	ST (min)	FT (μm)	CS (MPa)	TS (MPa)	MOE (GPa)
		2 min.	24 hrs.							
Zinc Phopsphate	Severe Irritant	2.14	6	0.2%	3 – 6	5 - 14	25	103.4	5-7	13
Zinc Polycarboxylate	Mild effect	3.42	7	0.06%	2.5 – 3.5	6-9	25-30	55-90	8-12	4-5
Glass Ionomer	Mild effect	2.33	5.68	0.4-1.5%	2-4	6-9	25	90-220	6-7	8-11
RMGIC	Mild effect	3-5		0.07-0.4%	2-4	5-6	25	85-126	13-24	2.5-7.8
Methacrylte resin cements	Moderate effect			0.0-0.01%		2-4	< 25	70-172		2.1-3.1

WT = Working Time
ST = Setting Time
CS = Compressive Strength
TS = Tensile Strength
MOE = Modulus of Elasticity.

ADVANTAGES

Zinc Phosphate	Zinc Polycarboxylate	Glass Ionomer	RMGIC	Resin Cement
1. Good compressive strength 2. Adequate film thickness (25µm) 3. Reasonable working time 4. Can be used in regions of high masticatory stress or long spam prosthesis	1. Biocompatibility with the dental pulp 2. Adequate resistance to water dissolution 3. Pseudoplastic 4. Favourable tensile strength 5. Chemical bonding	1. Anticariogenic 2. Ability to absorb fluoride recharge from the oral environment makes it the cement of choice in patients with high caries rate 3. Coefficient of thermal expansion like tooth 4. Translucent 5. Adequate resistance to acid dissolution 6. Low film thickness and maintains constant viscosity for a short time after mixing 7. Chemical bonding	1. Improved compressive strength and flexural strength 2. Less sensitive to early moisture contamination and desiccation during setting 3. Less soluble than the glass ionomer cement 4. Easy to manipulate 5. Adequately low film thickness 6. Fluoride release like conventional GIC 7. Minimal post-operative sensitivity 8. High bond strength to moist dentin	1. Superior compressive and tensile strengths 2. Low solubility 3. Available in wide range of shades and translucencies

DISADVANTAGES

Zinc Phosphate	Zinc Polycarboxylate	Glass Ionomer	RMGIC	Resin Cement
1. Highly acidic 2. Low tensile strength 3. No chemical bonding 4. Solubility in oral fluids 5. Lack of antibacterial 6. Properties	1. No resistance to acid dissolution 2. Manipulation critical 3. Early rapid rise in film thickness that may interfere with proper seating of a casting	1. Initial slow setting 2. Sensitivity to early moisture contamination and desiccation 3. MOE is lower than zinc phosphate 4. Post cementation sensitivity 5. Insufficient wear resistance	1. Polymerization shrinkage 2. More water absorption due to presence of HEMA 3. Although rare, may elicit an allergic response due to free monomer 4. Cement bulk is very hard and difficult to remove	1. Severe pulpal reactions when applied to cut vital dentin 2. High film thickness 3. Marginal leakage due to polymerization shrinkage 4. Lack of anticariogenic properties 5. Low MORE 6. No chemical bonding 7. Meticulous and critical manipulate on technique

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