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Recent advancements in medicated root canal sealers: An advanced step in creating bacteria free obturation

Dr. Deshpande M Prashanth

1. Introduction
Sealer's are the binding agents use to fill up the gap between the root canal walls and the obturating materials.[1] It also fill up the irregularities, discrepancies, lateral canals and accessory canals.

2. History
1. 1931 – Original ZOE cement by Rickett.
2. 1952 – Biocalex introduced by Bernard.
3. 1955 – Scheufere introduced resin based Diaket sealer.
4. 1956 – Grossman's non staining ZOE formula appeared as a sealer.
5. 1960 – Withtelle and Lim introduced plastic material hydron.
6. 1961 – Tubliseal was introduced with a slight modification to Ricket's formula.
7. 1965 – Nybord and Tullin formula of Kloropercha.
8. 1973 – N2 was introduced by Sargenti.
9. 1976 – Putford recommended endodontic glass ionomer ketac-endo as a root canal sealer.
10. 1985 – Browne developed calcium phosphate cement.
11. 1990's – Inorganic agents which have biocompatibility with biological tissues like the bioceramics have been developed focussed mainly on apatite type and tricalcium phosphate.
12. 2004 – Epiphany and gutta flow

3. Ideal Requirements
The requirements of a good root canal sealer are as follows:
1. Should provide an excellent seal when set.
2. Produce adequate adhesion among it, the canal walls, and the filling material.
3. Should be radiopaque.
4. Non-staining.
5. Dimensionally stable.
6. Should be easily mixed and introduced in to canals.
7. To be easily removed if necessary.
8. Insoluble in tissue fluids.
9. Bactericidal or discourage bacterial growth.[2]
10. Non-irritating to periapical tissues.
11. Should be slow setting, to ensure sufficient working time.
12. It should not be mutagenic or carcinogenic.

Should be absorbable when extruded into periapical tissues.

4. Functions of Sealers
1. Antimicrobial agent. [3]
2. Binding agent
3. A filler
4. A lubricant
5. Radiopacity

5. Classificaiton

5(1) According to Messing

1. Eugenol.
2. Non-eugenol.
3. Medicated.

i) Eugenol

a. Silver containing

i. Kerr sealer (Ricket 1931)

b. Silver free cement

ii. Procosol radioopaque Ag cement (Grossman 1936)

1. Procosol non staining cement (Grossman 1958)
2. Grossman sealer (Grossman 1974)
3. Tubliseal (Kerr, 1961)
4. Wach's paste (Wach 1925)

ii) Non Eugenol

1. Diaket
2. AH-26
3. Chloropercha + Eucapercha
4. Nogenol
5. Hydron
6. Endofil
7. Glass ionomer
8. Poly carboxylate
9. $CaPO_4$ cements
10. Cyanoacrylate

iii) Medicated

1. Diaket – A
2. N2
3. Endomethasone
4. SPAD
5. Iodoform paste
6. Riebler's paste
7. Mynal cement
8. $Ca(OH)_2$ paste (Lanes 1962)
9. $Ca(OH)_2$ paste (Frank, 1962) (Biocolex)
10. Endofloss

6. Medicated Root Canal Sealers

6.1: Diaket A

6.1(a) Chemically this sealer is similar to Diaket but it also contains the disinfectant hexachlorphene.

6.1(b) Diaket is one of the few medicated cements which does not contain paraformaldehyde.

6.2: Riebler's paste

Paraformaldehyde based

Composition

Powder	Liquid
Zn oxide	Formaldehyde
Formaldehyde	Sulfuric acid
Barium sulfate	Ammonia
Phenol	Glycerine

6.3: MYNOL CEMENT

Iodoform based

Composition

Powder	Liquid
Zn oxide	Eugenol
Iodoform	Creosol
Resin	Thymol
Bismuth subnitrates	

- Used without core materials,
- Introduced into the root canal by means of either a lentulospiral or some type of injection device.

6.4: N2

- Introduced by Sargenti and Ritcher in 1961. [4]
- N2 refers to the so called second nerve.

Initially 2 different types of N2 sealers were available :

- N2-Normal – Used for root filling.
- N2-Apical – Used for antiseptic medication of canal.
- Recently N2-'Universal' a cement containing the features of both N2-Normal and N2-Apical has been introduced. The formula has been altered by removing hydrocortizone, prednisolone and barium sulfate

Composition of N2-Universal

Powder		Liquid
Zinc oxide	**68.51g**	Eugenol
Lead tetroxide	**12g**	Cleum Rosea
Paraformaldehyde	4.7	Cleum Lavandular
Bismuth subcarbonate	2.60g	
Bismuth subnitrate	3.7g	
Titanium dioxide	8.4g	
Phenyl mercuric borate	0.09 g	

Toxicity

- Degree of irritation is severe when overfilling with N2 is forced into the maxillary sinus or mandibular canal persisting paraesthesia was observed.

- Blood lead level is increased after the insertion of root filling.

Effectiveness of sealers
- Apical seal with N2 is better when compared to procosol, nogenol, tubliseal and diaket.

6.5: Endomethasone
- The formulation of this sealer is very similar to N2 composite.
- Pink antiseptic powder

Composition

Powder		Liquid
Zinc oxide	100g	Eugenol
Bismuth subnitrate	100g	
Dexamethasone	0.019g	
Hydrocortisone	1.6g	
Thymol iodide	25.0g	
Paraformaldehyde	2.20g	

- Endomethasone root canal sealers give rise to pain or discomfort after 6-8 weeks of insertion. This occurs because corticosteroids marks any inflammatory reaction until it is removed from the area.

6.6: SPAD
- One visit non irritant radioopaque filler and sealer.
- It is a resorcinal formaldehyde resin supplied as a powder and two liquids.

Composition

Powder		**Liquid (Clear)**	
ZnO	72.9g	Formaldehyde	57.0g
Barium sulfate	**13.0g**	Glycerine	13.0g
Titanium dioxide	6.30g		
Paraformaldehyde	4.70	**Liquid (Red)**	
Hydrocortizone acetate	2.00g	Glycerine	55g
Calcium hydroxide	0.44g	Resorcinal	25g
Phenyl mercuric borate	0.16g	Hydrocloric acid	20g

Manipulation
- Equal parts of the 2 liquids are mixed with the powder. The essential reaction to form the resin is between the resorcinal and the formaldehyde.
- Setting time of SPAD is 24 hrs.

Indications
- Pulpotomies in both deciduous and permanent teeth.
- For treatment of acute endo infection.
- Teeth with periapical areas.
- When SPAD is used in treatment of periapical infection a small amount is intentionally introduced beyond the apex with the belief that sterilization helps healing.

6.7: Iodoform Paste
1. Resorbable paste used alone or in combination with other core materials.
2. WALKHOFF in 1928
3. ***Composition***
4. 60 parts iodoform
5. 40 parts parachlorophenol
   i. 45% parachlorophenol
   ii. 49% camphor Antiseptic medication
   iii. 6% Menthol
6. Commercially known as Kri-1 paste.
7. ***Advantage:***
8. Stimulates the periapical tissues
9. Excess accelerates bone formation.
10. ***Disadvantages :***
11. Periapical irritation.
12. Discolouration.
13. Causes increased iodine level in blood, hence contraindicated in patient with sensitive to iodine.
14. 45% Acqeous parachloraphenol solution causes mild connective tissue inflammatory response
15. Camphorated parachlorophenol is a highly toxic preparation causes tissue necrosis.

6.8: Calcium hydroxide cement
1. Used in conjunction with solid core materials.
2. Pure Calcium hydroxide powder alone or in combination with normal saline solution. Methyl cellulose, anesthetic solution pH- 12.5-14.5.
3. The use of Calcium hydroxide paste is based on the assumption – there is formation of hard structure or tissue at the apical foramen.
4. The activity of calcium hydroxide stimulate the induction of alkaline phosphate, thus forming hard tissue.

6.9: CRCS
- Introduced in 1982
- Termed the calcibiotic root canal sealer was the first of the calcium hydroxide based sealer.[5]
- Is a zinc oxide eugenol eucalyptol sealer to which calcium hydroxide has been added for its osteogenic effect.

Composition

Powder	**Liquid**
Zinc oxide	Eugenol
Hydrogenated rosin	Eucalyptol
Barium sulfate	
Calcium hydroxide	
Bismuth subcarbonate	

- It is mixed like any other powder:liquid sealer sets both in dry and wet canals.
- It takes 3 days to set fully in either dry or humid environment, shows little water sorption which makes it stable and improves its seal and quality.

6.10: Sealapex : (Kerr)
- Non eugenol calcium hydroxide polymeric resin root canal sealer.
- It is delivered as paste to paste formulation.

Composition:
BASE
- ZnO with Ca(OH)2,

- Butyl benzene,
- Sulfonamide and
- Zinc stearate

Catalyst
- Barium sulfate,
- Titanium dioxide as radioopacifiers with proprietary resin
- Isobutyl salicylate and
- A crocil R 972.

Manipulation

6.11: Biocalex :
- Developed and introduced by Bernard in 1952.

Composition

Powder	Liquid
Heavy calcium oxide	Glycol
Zinc oxide	Water

- Powder and liquid are mixed to form a paste.

Progressively expands to more than 6 times its original volume. So it is not necessary to prepare the root canal prior to root canal filling. Calcium oxide and water react within the tooth to form the calcium hydroxide which ionizes to release OH ions. These OH ions decomposes necrotic pulpal tissue to form water and carbondioxide.

6.12: Life
- Calcium hydroxide liner and pulp capping material similar in formulation to seal apex.

6.13: Vitapex
- Introduced by Japanese researcher. Calcium hydroxide sealer containing 40% iodoform, also contain silicon oil.

Advantage
- Iodoform a known bactericide is released from the sealer to suppress any lingering bacteria in the canal or periapex.

6.14: Endofloss
- It is zinc oxide based medicated sealer consisting of powder: liquid formulation.

Powder
- Zinc oxide.
- Iodoform.
- Calclium hydroxide.
- Barium sulphate.

Liquid
- Eugenol.
- Setting time is approximately 30-45 minutes
- Relatively biocompatible and absorbable sealer.
- Induces severe inflammatory reaction in 48 hours and gradually reduced after 3 months.
- Severe cytotoxicity was observed along with coagulation necrosis which is attributed to be presence of iodoform parachlorphenol.
-

6.15: Recent Development

As a biological root canal sealing agents, bone powder, dentin slices, calcium hydroxide or its products have been attempted so far. Bone powder and dentin slices were difficult to purchase and caused immunologic reactions. Calcium hydroxide was resorbed by living body without setting. Recently inorganic agents which have biocompatible, the Bioceramics have been developed mainly based on apatite type agents calcium phosphate. Recently several root canal sealers composed of hydroxyapatite and related tricalcium phosphate (TCP) have been promoted.

Advantages
- Appear to be more biocompatible.
- Effective in healing mechanical perforation of pulp chamber floor.
- Pulp capping.
- Enhancement of bone fill after periapical surgical procedure.

6.16: Tricalcium Based Sankin Apatite Root Canal Sealer
- ***Appetite Root Canal Sealer***
- Composed of hydroxyapatite and tricalcium phosphate.
- 3 types.

Type I
- *Powder*
- Tricalcium phosphate – 80%.
- Hydroxy apatite – 20%.

Liquid
- Polyacrylic acid – 25%.
- Water – 75%.
- This is used for vital pulpectomy.

Type II

Powder:
- Tricalcium phosphate – 52%.
- Hydroxyapatite – 14%
- Iodoform – 30%.

Liquid
- Polyacrylic acid – 25%
- Water – 75%
- Used in infected canals

Type III:

Powder
- Tricalcium phosphate – 80%.
- Hydroxyapatite – 14%
- Iodoform – 5%
- Bismuth subcarbonate – 1%

Liquid
- Polyacrylic acid – 25%
- Water – 75%
- Used in cases of accidental perforation and retrograde filling material.

6.17: Newly Developed Calcium Phosphate Type Sealers Are
- Tetracalcium phosphate
- Dicalcium phosphate dihydrate
- A modified McIIvain's and Buffer solution
- TDM-S-Buffer solution + 2.5% Chondroitin sulphate.

6.18: Tdm-S Buffer Solution
Composition
Powder
- Tetracalcium phosphate
- Dibasic calcium phosphate

Liquid
- Citric acid
- Dibasic sodium phosphate
- Condroitin sulphate
- Distilled water

6.19: A Modified Mciivain's & Buffer Solution
Composition
Powder
- Tetracalcium phosphate
- Dibasic calcium phosphate

Liquid
- Citric acid
- Dibasic sodium phosphate
- Condroitin sulphate
- Distilled water

Sealer Application
After the selection of the compacting instruments and drying the canal. The root canal sealer is placed in the canal. The effective distribution of root canal sealers throughout the root canal system has been suggested as essential to obtain the best possible root canal seal.
The various methods of sealer placement are with lentula spirals, files and reamers, master gutta percha cones and ultrasonic instruments.
In cold lateral composition method, the use of master cone, a file, or a lentula to place the sealer is acceptable. For the best distribution of a sealer, the placement of sealer with an ultrasonic instrument should be considered whatever vehicle is choosen, it is lightly coated with the sealer and placed in the canal, distributing the sealer evenly over the prepared walls. In larger canals this may have to be done more than once. For lateral compaction the sealer is to be placed to the working length of the canal, the complete filling of the canal with sealer should be avoided.

Conclusion
Root canal sealers along with the solid core play a major role in achieving the hermetic seal by filling the accessory canals, voids, spaces and irregularities. Many studies were conducted which concluded that the sealer was essential for effective obturation. Yoynes and Hembree showed that a canal filled with a combination of gutta-percha and sealer achieved more successful seal that either gutta-percha or sealer alone. Each one of the sealer has its own merits and demerits. Zincoxide eugenol is the most commonly used sealer, this was the standard sealer in many studies for comparing with other sealers. Many of the other sealers like glass ionomer, AH-26, life, diaket, hydron etc have tested for their sealing efficiency but none of them have showed cent percent results.
Current research on inorganic agents, which have the compatibility with biological tissue, the bioceramics i.e. hydroxyapatite sealers have been encouraging results and thus require more research.

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