

Recent Advances in Endodontic Sealers

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GLASS IONOMER SEALERS

- First introduced as a sealer in 1991 by ESPE under brand name ***Ketac-Endo***
- **Rationale** :- Due to **bonding** properties, glass ionomer **prevents percolation** and bacterial penetration at sealer-dentin interface
- When mixed, they form repeating subunits of organic monomer and inorganic ions, creating an ionomer

Ketac Endo

POWDER

- Calcium aluminium lanthanum fluorosilicate glass
- Calcium wolframate
- Silicic acid
- Pigments

LIQUID

- Polyethylene polycarbonic acid/Maleic acid Copolymer
- Tartaric acid
- Water
- **Setting Time:** 2.5 hr
- **Solubility:** 1.6%

Differs from the standard glass-ionomer cements in having :-

1. A **longer working time**
2. Higher **radiopacity**
3. **Thixotropic consistency** that allows it to flow into the root canal

(Vesuksit C et al, 1988)



Author	Study
<i>Timpawat S et al (2001)</i>	Glass-ionomer sealer significantly strengthened the root , compared with roots instrumented but not obturated and those obturated with gutta-percha and ZOE sealer
<i>Jhamb S et al (2009)</i>	Ketac-Endo shows higher fracture resistance values in comparison to Ca(OH)₂ and Epoxy sealer

Experimental GIC Sealers

KT-308 is conventional GIC with increased radiopacity and extended working time

ZUT is KT-308 combined with antimicrobial agent, a silver containing zeolite (0.2-20% weight)

Patel et al.
1998

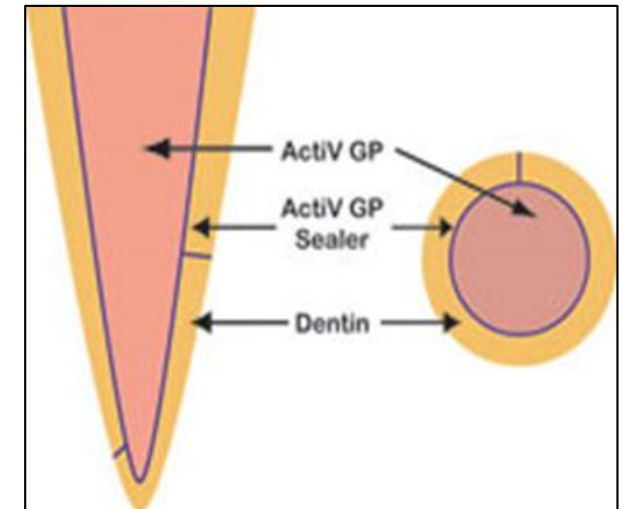
ZUT demonstrated an effective suppression of adherent *E. faecalis* over a period of 12 weeks which promotes its efficacy as a root canal sealer

Activ GP (Brasseler USA, Savannah Georgia)

Glass ionomer impregnated gutta-percha cone with a glass ionomer external coating and a glass ionomer sealer.

They are available in **0.04 and 0.06 tapered cones**.

This single cone technique is designed to provide a bond between the dentinal canal wall and the master cone to form a monoblock



DISADVANTAGES OF GIC SEALERS

- It is difficult to remove from the root canal in the event of retreatment
- Extensive Leakage

GUTTA PERCHA SEALERS / CHLOROFORM BASED SEALERS

- **Rationale :-** Gutta percha **may be dissolved** in various solvents, such as *chloroform, oil of eucalyptus, or xylol*.
- Gutta-percha **particles** are added to the chloroform to produce a sealer, which has the same color as gutta-percha.
- The **mixture** can then be used as a sealer **with gutta-percha points** for obturation of the canal.

CHLOROPERCHA

- Gutta-percha with chloroform
- Has no adhesive properties.
- Draws its toxicity from the chloroform component

Kloropercha N-Ø

- Powder :- contains about 20% Gutta percha and 50% zinc oxide
- The remaining components are Canada balsam (19%) and rosins (11%)
- Liquid :- Chloroform
- After the loss of chloroform, the sealer may be irritating due to its content of rosins and Canada balsam
- The combination with zinc oxide, however, will provide a significant level of cytoprotection in clinical use

Callahan–Johnson Technique

Canals flooded with chlororodin solution.

Spreads extensively into inaccessible eccentricities in the root canal

Acts as a solvent both for a previously prepared **master cone** and for **organic material**

When the master cone and additional cones are added in the condensation procedures, dissolved gutta percha will diffuse effectively into otherwise inaccessible portions of the root canal system



Nygaard–Ostby Technique

- Finely ground specially prepared *gutta percha particles* are spatulated with chloroform
- To produce paste which will be used in ***conjunction with the master gutta percha*** cone
- This method is reported to reduce apical excess and the shrinkage in the final filling

Disadvantages

- All of the solvents used are highly volatile
- The amount of shrinkage varies directly with the amount of solvent used
- Excessive shrinkage, failure may result from the inadequate sealing of the root canal
- Excess solvent - difficult to confine the plastic material to the root canals, and gross excess may be forced into the periodontal tissues

Studies by the American Food and Drug Administration have demonstrated that chloroform is potentially carcinogenic

The Council on Dental Therapeutics of the American Dental Association decided to withdraw chloroform from Accepted Dental Therapeutic

Chloroform can be substituted with eucalyptol, an organic solvent derived from eucalyptus trees.

EUCAPERCHA

By Buckley

- Eucalyptol does not dissolve gutta percha rapidly as does chloroform
- Replaced chloropercha because chloroform considered a potential carcinogen
- Is a paste made by softening surface of gutta –percha in warm oil of eucalyptus (eucalyptol)
- The softened gutta – percha used to coat the canal wall with a thin film of eucapercha

Disadvantages

- Difficult to avoid overfilling the canal
- If extruded, acts as an irritant initially

Resin Based Sealers

1. Polyketone based sealers
2. Epoxy resin sealers
3. Methacrylate resin- based sealers

Polyvinyl/Polyketone Based Sealers

DIAKET (3M/ESPE)

- Schmidt in 1951
- Polyketone compound containing vinyl polymers mixed with zinc oxide and bismuth phosphate.”
- **Liquid** :- B-diketone
- Sets by chelation
- Tacky material that contracts upon setting, but this is offset by its absorption of water
- Initial mild tissue reactions, which decrease after 2 weeks

Advantages

- Good adhesion
- Fast setting
- Superior tensile strength

Disadvantages

- Toxic in nature
- Tacky material difficult to manipulate
- Tissue irritation if extruded

DIAKET A

- Chemically similar to Diaket but contains disinfectant Hexa Chlorophene
- One of the few medicated cement

Epoxy Resin Based Sealers

AH 26

- Epoxy resin was invented in 1938 by P. Castan, a Swiss chemist of de Trey (Zurich, Switzerland)
- Characterized by the reactive epoxide ring and are polymerized by breaking this ring
- Feldman and Nyborg gave the following composition.

Powder	Liquid
Bismuth Oxide – 60%	Bisphenol diglycidyl ether
Hexamethylen Teramine – 25%	
Silver Powder – 10%	
Titanium Oxide – 5%	

Advantages

- Not effected by moisture
- Setting time: 24-36 hours at body temperature
5-7 days at room temperature
- Greater adhesion to dentin
- Low solubility

Disadvantages

- Silver containing
- Formaldehyde releasing
- Contracts while hardening

In 1993, Spångberg et al. reported that AH 26 releases formaldehyde which recommended transition from AH 26 to AH Plus, which does not release formaldehyde



▪ AH Plus

- AH Plus is an Epoxide-Amine resin root canal sealer, developed from its predecessor AH-26
- Because of color and shade stability, this is the material of choice where esthetic demands are high
- Easy-to-mix
- Adapts closely to the walls of the prepared canal and
- Minimal shrinkage upon setting
- Outstanding long-term dimensional stability

Paste A	Paste B
Di-epoxide	1-adamantine amine
Calcium Tungstate	N-N- di benzyl-5-oxa-nonane-diamine- 1,9 TCD-diamine
Zirconium Oxide	Zirconium Oxide
Iron Oxide	Aerosil (Silica)
Aerosil (Silica)	Silicon oil

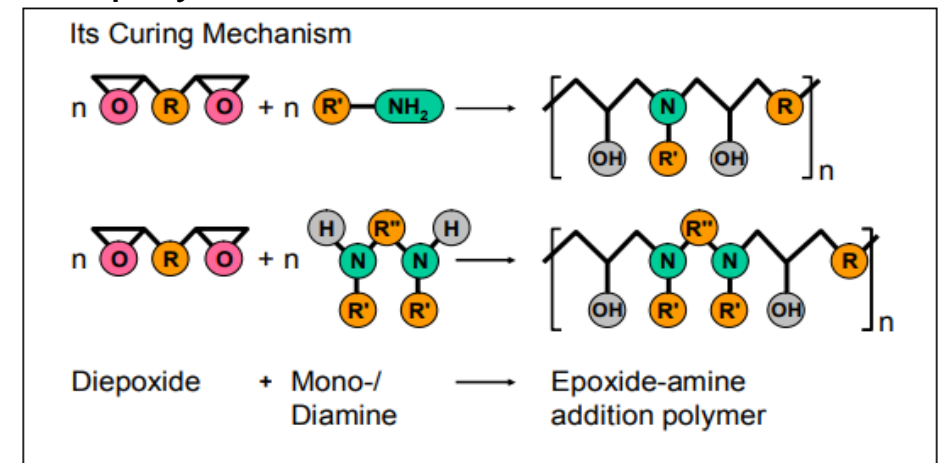
Properties	Values
Working Time	4 hr
Setting Time	8 hr
Flow	36 mm
Film Thickness	26 μ m
Shrinkage	1.76%
Solubility	0.31%



Mixing

Mix equal volume units (1:1) of Paste A and Paste B on a mixing pad. Mix to a homogeneous consistency.

- ❑ The mixed and polymerised AH Plus has a filler content of 76% in weight
- ❑ Poly addition “step growth” reaction
- ❑ Monomers, diepoxides and amine, react to oligomers with epoxy - and amino- end groups
- ❑ Can further get added with remaining monomers or other oligomers
- ❑ As a result of this polyaddition, high-molecular weight addition polymers are formed



AH 26	AH Plus
<ul style="list-style-type: none"> ▪ Powder and liquid system 	<ul style="list-style-type: none"> ▪ Two paste system
<ul style="list-style-type: none"> ▪ Releases small amount of formaldehyde on mixing, which has antibacterial action and makes it toxic in nature 	<ul style="list-style-type: none"> ▪ Less toxic
<ul style="list-style-type: none"> ▪ Causes staining 	<ul style="list-style-type: none"> ▪ No staining
<ul style="list-style-type: none"> ▪ Film Thickness: 39µm (good flow) 	<ul style="list-style-type: none"> ▪ Film Thickness: 26 µm (better flow)
<ul style="list-style-type: none"> ▪ Setting Time: 24-36 hr 	<ul style="list-style-type: none"> ▪ Setting Time: 8 hr
<ul style="list-style-type: none"> ▪ Radiopaque 	<ul style="list-style-type: none"> ▪ Radiopacity better than AH 26
<ul style="list-style-type: none"> ▪ Not sensitive to moisture and shows less solubility 	<ul style="list-style-type: none"> ▪ Half solubility compared to AH 26

METHACRYLATE RESIN BASED SEALERS

- Four generations of methacrylate based sealers have been introduced

First generation of hydrophilic methacrylate resin–based material (**Hydron**) to be injected into a root canal and polymerized without the adjunctive use of a root-filling material

Second Generation: a dual cure sealer (hydrophilic) that does not require a dentin adhesive (**EndoREZ**)

Third Generation methacrylate-based sealers make use of formulations containing self-etching primers, (**Epiphany**)

Fourth-generation methacrylate-based sealers include a combination of self-activating etchant, primer, and sealer (**MetaSEAL**)

MONOBLOCK CONCEPT

- **Franklin R Tay** introduced the monoblock concept in Endodontics
- In endodontics the term monoblock is used to signify a scenario where in the canal space is perfectly filled with a gap-free, solid mass that consists of different materials and interfaces
- This gap free solid mass filling may imply either a root canal obturating material or a post and core system

▪ **Based upon these interfaces monoblocks are classified into:**

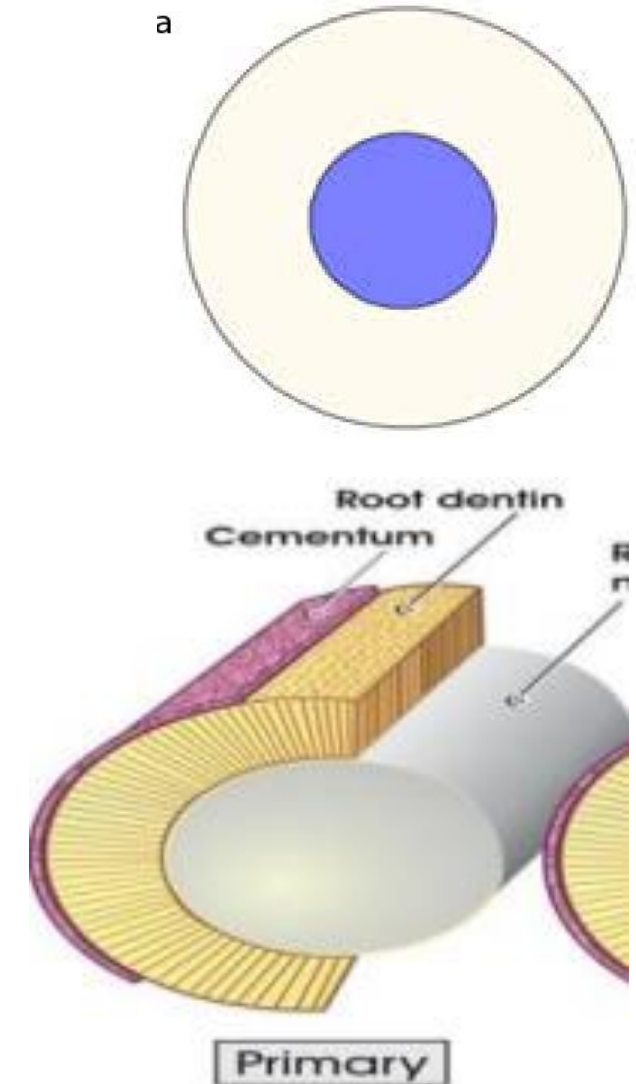
1. Primary monoblock
2. Secondary monoblock
3. Tertiary monoblock

Prerequisite for formation of Monoblock

- Material that constitute a monoblock should have the ability to bond strongly and mutually to one another, as well as to the substrate that monoblock is meant to reinforce

Primary Monoblock

- Has only one interface that extends circumferentially between the material and the root canal form
- **Examples:**
 1. Mineral Trioxide Aggregate (MTA)
 2. Hydron
 3. Biogutta
- **Properties of materials:**
 1. Easy manipulation
 2. Nonirritating with acceptable adaptability
 3. Ability to calcify even if it gets forced out of the canal accidentally



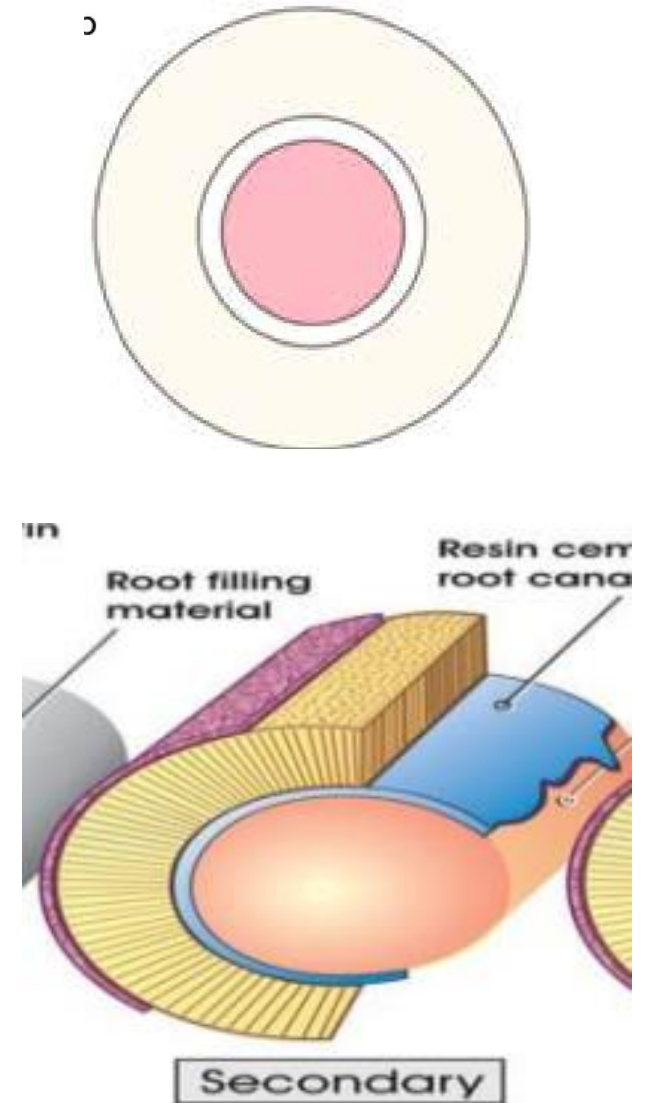
Mahajan A, Kaur NP, Ayoub K. Monoblocks in root canals: A review. International Journal of Health Sciences. 2021;5:113-21.

Kittur M, Ghivari S, Pujar M, Astekar D, Arora N. The monoblock concept in endodontics. IP Indian Journal of Conservative and Endodontics. 2020 Dec 15;3(4):101-3.

Secondary Monoblock

- Two circumferential interfaces are formed one between the cement - core material and other between cement-dentin
- **Examples**
- Use of sealer for obturation with GP Points
- Resilon/Epiphany: applied using a methacrylate-based sealer to self-etching primer treated root dentin

It contains two interfaces, one between the sealer and primed dentin and the other between the sealer and resilon

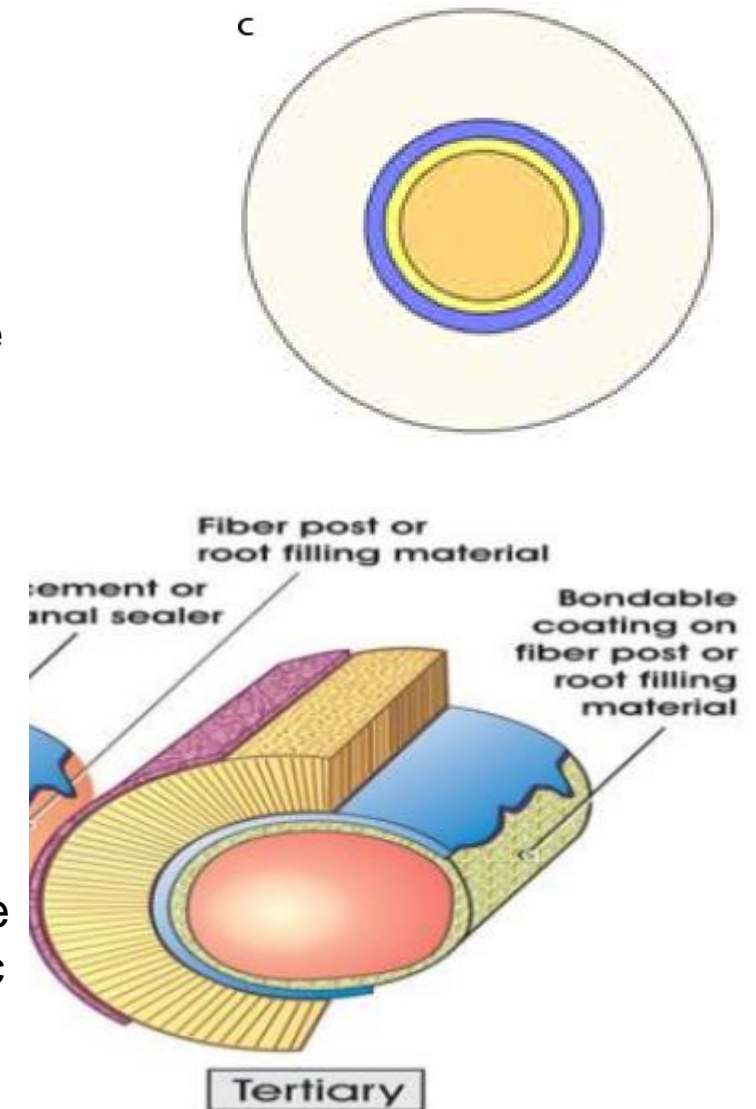


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Tertiary Monoblock

- A third circumferential interface is introduced between the bonding substrate and abutment material
- The introduction of a tertiary interface is intricate in that gaps may be present between the core material and its surface coating
- These gaps may raise the stress and result in eventual adhesive failure and dislodgement of the core material
- **Examples:**
 - Endo Rez
 - Activ GP system
 - Fiber posts that contain:
Unpolymerized resin composite for relining root canals that are too wide or not perfectly round for the fitting of conventional fiberposts (Anatomic Post, RTD, France)



Mahajan A, Kaur NP, Ayoub K. Monoblocks in root canals: A review. International Journal of Health Sciences. 2021;5:113-21.

Kittur M, Ghivari S, Pujar M, Astekar D, Arora N. The monoblock concept in endodontics. IP Indian Journal of Conservative and Endodontics. 2020 Dec 15;3(4):101-3.

Hydron (Hydron Technologies, St. Petersburg, FL, USA)

- Introduced by **Wichterle and Lim in 1960**
- Hydron is a polymer of hydroxy ethyl methacrylate (HEMA)
- It is available as injectable root canal filling material
- Rapid setting
- Injected into the root canal and polymerized for en masse root canal filling (without use of a core)
- **Working time** is 6-8 minutes
- **Setting time** is 10 minutes

Advantages:

- Biocompatible material that conforms to the shape of the root canal because of its plasticity.

Disadvantages:

- Syringe method makes it difficult to control placement of sealer accurately
- Radiopacity is very low, complicates radiographic observation of an overfill
- Overfilling with hydron causes long-term periapical inflammation so tissue tolerance of hydron is controversial
- Difficult to removed from the canal

ENDO REZ (Ultradent Products, South Jordan, UT)

- Hydrophilic, dual cure radiopaque sealer
- Does not require the adjunctive use of a dentin adhesive
- **Resin tag formation** for retention and seal after smear layer removal
- Supplied in a Two-paste mixing and delivery syringe
- Introduced into the canal with a narrow **30-gauge navitip** needle
- **COMPOSITION**
 1. Resins
 2. Zinc oxide
 3. Barium sulfate
 4. Pigments in a matrix of urethane dimethacrylate resin

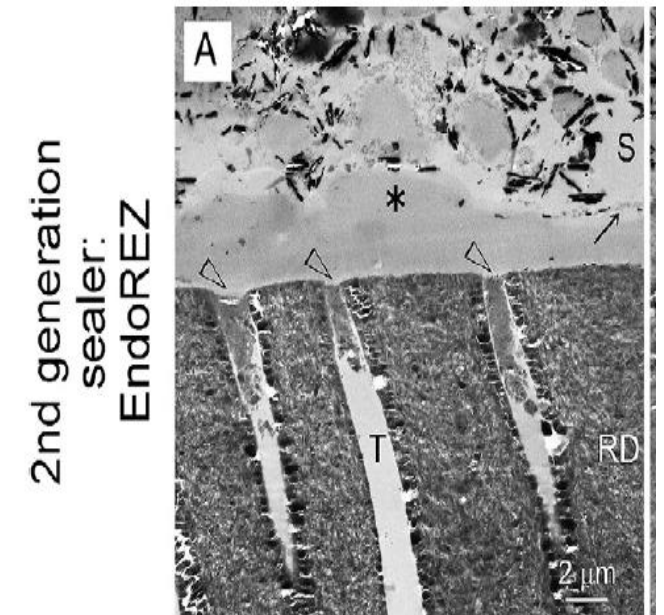


Recommended for use with :-

- Conventional gutta-percha cone
- Specific endorez points (resin-coated gutta-percha)

PROPERTIES

- ✓ Has radiopacity similar to gutta percha cones
- ✓ Excellent sealing properties
- ✓ Good adaptation to the root canal walls in the presence of moisture
- ✓ Effective penetration of material into the dentinal tubules
- ✓ Remains soft and plastic for a long period of time



Komabayashi T, Colmenar D, Cvach N, Bhat A, Primus C, Imai Y. Comprehensive review of current endodontic sealers. Dental materials journal. 2020 Sep 28;39(5):703-20.

Jensen SD, Fisher DJ. Method for filling and sealing a root canal. US Patent & Trademark Office. Patent number 6,811,400, November 2, 2004

Epiphany-Resilon (Resilon Research, Madison, CT, USA)

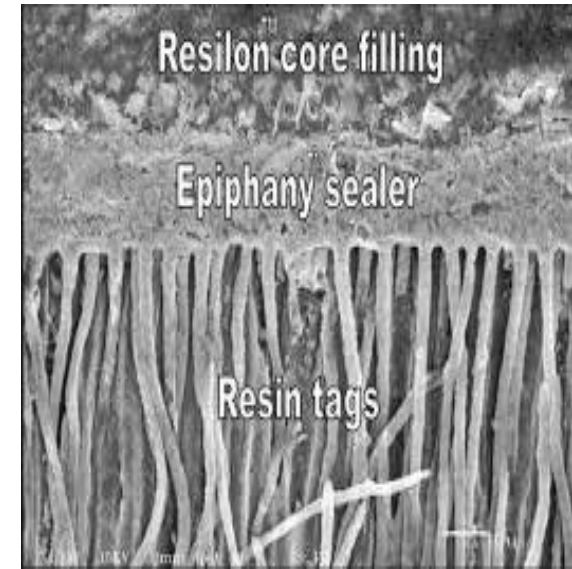
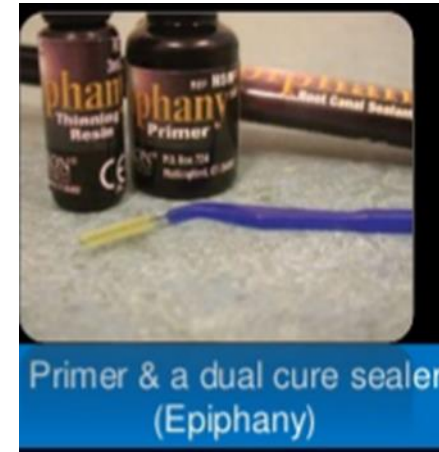
- Is a dual-curing, hydrophilic resin sealer
 - Used with Resilon core materials
 - Dispensed from a double barrel, auto-mix syringe
- i) Greater ease of use
- ii) Accurate mixing
- Composition

Resin Matrix	Additional components
Mixture of Bis GMA	Barium Borosilicate Glass
Ethoxylated Bis GMA	Barium Sulfate
UDMA	Calcium Hydroxide
Hydrophilic difunctional methacrylates	Silica
	Bismuth Oxychloride



Total Filler Content: 70%

- Self-cures in about 25 minutes
- **Epiphany** Self-etch primer contains
 1. Sulfonic acid terminated functional monomer
 2. Hydroxyethylmethacrylate (HEMA)
 3. Water
 4. Polymerization initiator



Properties

- ✓ Bonds to both the Epiphany Primer and Resilon Obturating material
- ✓ Can be light cured for an immediate coronal seal
- ✓ Self cures apically in 25 minutes
- ✓ Shrinks 2-3% on polymerization
- ✓ Highly radiopaque
- ✓ Easy to remove
- ✓ Resorbable
- ✓ Less irritating than epoxy resin or ZOE sealers

Advantages	Disadvantages
Excellent sealing capability due to creation of a “monobloc” which adheres to the dentin walls	Polymerization shrinkage
Provides an immediate coronal seal	Cytotoxic when extruded
	Water sorption leads to disruption of bonds
	Bond strength lesser than conventional GP/sealer

Tyagi S, Mishra P, Tyagi P. Evolution of root canal sealers: An insight story. *European Journal of General Dentistry*. 2013 Sep;2(03):199-218.

Komabayashi T, Colmenar D, Cvach N, Bhat A, Primus C, Imai Y. Comprehensive review of current endodontic sealers. *Dental materials journal*. 2020 Sep 28;39(5):703-20.

Resilon

- Developed to replace gutta-percha and traditional sealers for root canal obturation.
- It offers solutions to the problems associated with gutta-percha:

Gutta Percha	Resilon
Shrinkage of gutta-percha on cooling	This resilon core material only shrinks 0.5 percent on setting, no gaps are seen due to shrinkage
Gutta-percha does not bind physically to the sealer, it results in gap formation between the sealer and the guttapercha	Physically bonded to the sealer by polymerization.

- It is biocompatible, non-cytotoxic and non mutagenic
- Excellent sealing ability attributed to the “mono block” which is formed by the adhesion of the resilon cone to the epiphany sealer, which adheres and penetrates into the dentin walls of the root canal system

Silicon Based Sealers

- RoekoSeal (Roeko, Lengenau, Germany)
- Endofill (Dentsply, Latin America, Brazil)
- Guttaflow (Coltene Whaledent)

Endofill (Dentsply, Latin America, Brazil)

- **Base:**

1. Bismuth sub-nitrate – Radiopacifier
2. Active components:
 - i. Hydroxyl terminated dimethyl poly-siloxane
 - ii. Benzyl alcohol
 - iii. Hydrophobic amorphous silica

- **Catalyst:**

1. Ethyl ortho-silicate
2. Poly dimethyl siloxane

- Setting time: 8-90 minutes



Advantages	Diadvantages
<ul style="list-style-type: none"> ▪ Easy to prepare 	<ul style="list-style-type: none"> ▪ Canal must be absolutely dry
<ul style="list-style-type: none"> ▪ Adjustable working time 	<ul style="list-style-type: none"> ▪ Shrinks upon setting
<ul style="list-style-type: none"> ▪ Low viscosity 	
<ul style="list-style-type: none"> ▪ Low toxicity 	
<ul style="list-style-type: none"> ▪ Good adaptation to the tooth structure 	

RoekoSeal (Roeko, Lengenau, Germany)

- **COMPOSITION** – Polydimethyl siloxane, Silicone oil, Paraffin base oil, Hexachloroplatinic acid, Zirconium dioxide
- Available in an automix syringe, or convenient single dose package

Properties

1. Excellent flow
2. Extremely biocompatible
3. Extremely low film thickness of 5 μm allows the sealer to flow into tiny crevices and dentinal tubules
4. Solubility virtually zero
5. Dimensional stability – expands slightly (0.2%) – outstanding seal with the canal walls
6. Highly radiopaque

Guttaflow (Coltene Whaledent)

- Guttapercha milled to a low grain size is mixed into polydimethylsiloxane (PDMS) matrix [Gutta-flow (Coltene Dental, USA)]
- Modification of RoekoSeal sealer, which contains small gutta-percha particles with a size of $<30\ \mu\text{m}$
- It has extraordinary chemical and physical properties that offer maximum sealing quality and biocompatibility
- Working time: 15min
- Setting time: 25-30min
- Solubility: 0.13%



Advantages	Diadvantages
<ul style="list-style-type: none"> ▪ Cures completely regardless of humidity or temperature 	<ul style="list-style-type: none"> ▪ Does not adhere chemically to the dentin
<ul style="list-style-type: none"> ▪ Flows into the smallest dentinal tubules, because of the small particle size of the matrix fillers 	<ul style="list-style-type: none"> ▪ Larger armamentarium needed
<ul style="list-style-type: none"> ▪ Material does not shrink, but expands slightly by 0.2% 	
<ul style="list-style-type: none"> ▪ Insolubility and homogeneity 	



Bioceramic Sealers

- Bioceramics are highly successful endodontic sealers and have several advantages such as:
 1. Their biocompatibility prevents rejection by the surrounding tissues
 2. Contain calcium phosphate which enhances the setting properties of bioceramics and results in a chemical composition and crystalline structure similar to tooth and bone apatite materials thereby improving sealer-to-root dentin bonding
- **Classified as:**
 1. Calcium Silicate Based Sealers
 2. MTA Based Sealers
 3. Calcium Phosphate Based

Setting Reaction

Zhang W et al., (2009)

Diffusion of the sealer particles into the dentinal tubules (tubular diffusion) to produce mechanical interlocking bonds

Infiltration of the sealer's mineral content into the intertubular dentin resulting in the establishment of a mineral infiltration zone produced after denaturing the collagen fibres with a strong alkaline sealer

Han L et al., (2011)
Amteh AR et al. (2012)

Zhang H et al., (2009)

Partial reaction of phosphate with calcium silicate hydrogel and calcium hydroxide, produced through the reaction of calcium silicates in the presence of the dentin's moisture, resulting in the formation of hydroxyapatite along the mineral infiltration zone

Calcium Silicate Based Sealers

EndoSequence BC Sealer (Brasseler USA)

- Premixed ready-to-use injectable bioceramic cement paste developed for permanent root canal filling applications
- Insoluble, radiopaque and aluminum-free material based on a calcium silicate composition
- Requires the presence of water to set and harden
- Does not shrink during setting and demonstrates excellent physical properties
- Packaged in a pre-loaded syringe and is supplied with disposable Intra Canal Tips



Composition

1. Tricalcium silicate
2. Dicalcium silicate
3. Calcium phosphates
4. Colloidal silica
5. Calcium hydroxide
6. Zirconium oxide as the radiopacifier
7. Water-free thickening vehicles to enable the sealer to be delivered in the form of a premixed paste

Al-Haddad A, Che Ab Aziz ZA. Bioceramic-based root canal sealers: a review. International journal of biomaterials. 2016 May 3;2016.

Tyagi S, Mishra P, Tyagi P. Evolution of root canal sealers: An insight story. European Journal of General Dentistry. 2013 Sep;2(03):199-218.

Setting reaction:

The setting reaction of EndoSequence BC Sealer is a two-phase reaction.

Phase I: Monobasic calcium phosphate reacts with calcium hydroxide in the presence of water to produce water and hydroxyapatite

Phase II: Water derived from the dentin humidity, as well as that produced by the phase I reaction, contributes to the hydration of calcium silicate particles to trigger a calcium silicate hydrate phase

Properties

1. Uses the moisture within the dentinal tubules after canal irrigation to initiate and complete the setting reaction
2. Setting time 4 hr, may be extended in overly dry canals
3. pH during the setting process is higher than 12 which increases its bactericidal properties

Al-Haddad A, Che Ab Aziz ZA. Bioceramic-based root canal sealers: a review. International journal of biomaterials. 2016 May 3;2016.

Tyagi S, Mishra P, Tyagi P. Evolution of root canal sealers: An insight story. European Journal of General Dentistry. 2013 Sep;2(03):199-218.

iRoot (Innovative BioCeramix Inc., Vancouver, Canada)

- iRoot SP is a calcium silicate-based aluminum-free root canal sealer
- iRoot SP is an injectable, ready-to-use, insoluble, radiopaque paste
- Needs moisture to initiate and complete setting reaction
- Introduced in three forms: iRoot SP, iRoot BP, and iRoot BP Plus
- These forms have been introduced for use in root filling, root repair (iRoot BP and iRoot BP plus), and root canal sealer (iRoot SP) materials
- **Composition:** Tricalcium silicate, Dicalcium silicate, Calcium phosphates, Colloidal silica, Calcium hydroxide, Zirconium oxide



- iRoot SP shows a significantly higher bond to dentin compared to MTA
- The smaller particle size and high level of viscosity increase the flow of the material into the dentinal tubules, other anatomic structures of the root canal space, when gutta-percha is used as the root canal filling material (Shokouhinejad *et al.* 2013).

Bio-C (Angelus)

- Recently developed bioceramic sealer
- Single syringe form

Component	Function
Tricalcium silicate	Calcium ion release
Dicalcium silicate	Calcium ion release
Tricalcium aluminate	Initial Setting
Calcium oxide	Calcium ion release
Zirconium oxide	Radiopacity
Silicon oxide	Rheology agent
Polythelene Glycol	Dispersing agent
Iron oxide	Pigment

- **Indications:**
- As a sealer with gutta percha
- In cases of non-communicating Internal resorption



Al-Haddad A, Che Ab Aziz ZA. Bioceramic-based root canal sealers: a review. International journal of biomaterials. 2016 May 3;2016.

Bio-C (Angelus) Brochure

Bio-C (Angelus)

- **Properties**

- Setting Time: 2-4 hours

- pH: 12

- Flow: 23.46 mm

- Particle Size: 2 μm

- Film Thickness: 21 μm

- Solubility: 2.86%

- **Setting Reaction:**

- Tricalcium Silicate + Water \longrightarrow Hydrated Calcium Silicate gel + Calcium Hydroxide
- Dicalcium Silicate + Water \longrightarrow Hydrated Calcium Silicate gel + Calcium Hydroxide
- Calcium Oxide + Water \longrightarrow Calcium Hydroxide

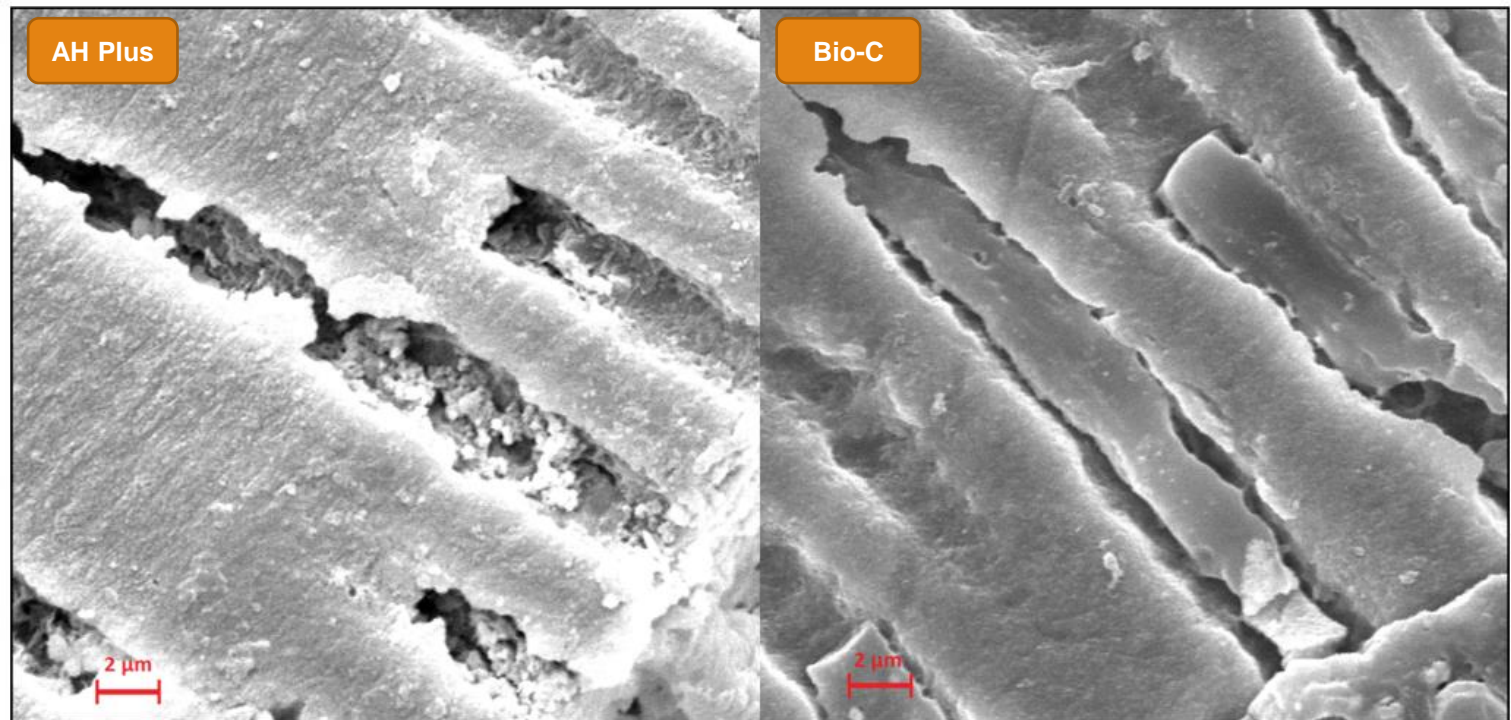
Dentinal Tubule Penetration and Adaptation of Bio-C Sealer and AH-Plus: A Comparative SEM Evaluation

Carolina CACERES, Maria Rosa LARRAIN, Macarena MONSALVE, Fernando PEÑA-BENGOA

Bio-C showed significantly higher penetration in dentinal tubules than AH Plus in the cervical, middle and apical thirds of the root canal and better adaptation to the dentinal tubule walls

AH-Plus showed less regularity, with a granular aspect and intratubular gaps, which could be due to its larger particle size, polymerisation shrinkage or problems during the mixing process.

Bio-C Sealer showed a smooth and consistent tubule penetration with few gaps. May be associated, with its hydrophilic nature and premixed presentation, with the nanometric particles present in its composition.



MTA Based Sealers

ProRoot Endo (Dentsply)

■ Powder

1. Tricalcium silicate
2. Dicalcium silicate
3. Calcium sulfate (Setting Retardant)
4. Bismuth oxide (Radiopacifiers)
5. Tricalcium aluminate (Initial hydration)

- Powder/Liquid Ratio:- 2:1

Liquid

Viscous aqueous solution of water soluble polymer



When placed in the canal, it initiates calcium activity after reaction with water and causes cell attachment and proliferation, increases the pH, modulates cytokines like interleukin (IL)

Endo CPM sealer (Egeo-Argentira)

- In 2004, CPM sealer was developed in Argentina, in an attempt to combine the sealing and physiochemical properties of root canal sealer with biological properties of MTA.
- **Powder** consists of fine hydrophilic particles that form a colloidal gel in presence of moisture
 1. Tricalcium silicate
 2. Tricalcium oxide
 3. Tricalcium aluminate
- **Liquid** solution consists of saline solution and calcium chloride

- **Setting Time:** 1 hour (Scarparo et al., 2010)
- **Properties:**
 - Antimicrobial activity
 - Satisfactory radiopacity
 - Culture with fibroblast revealed that it is not cytotoxic (Tanomaru et al.,2007)

MTA Fillapex (Angelus)

- Ease of delivery – no waste, and exhibits excellent handling properties

Paste A	Paste B
Salicylate Resin	Fumed Silica – Filler
Bismuth Trioxide – Radiopacity	Titanium dioxide – Pigment
Fumed Silica – Filler	Mineral Trioxide Aggregate – Active component



Syringe with automix tip - 4g



Base paste tube - 18g
Catalyst paste tube - 12g

- **Setting Time:** 2 hours
- **Flow Rate:** 22 mm
- It has excellent antibacterial properties
- Solubility is extremely low (0.1%)
- Alkaline pH

Spectrophotometric analysis of crown discoloration induced by MTA- and ZnOE-based sealers

AUTHORSHIP

SCIMAGO INSTITUTIONS RANKINGS

- Three groups Group 1: MTA Fillapex, Group 2: Roth 811, Group 3: Negative control (unfilled) and immersed in individually marked vials containing distilled water up to the cervix ($37\pm 1^{\circ}\text{C}$)
- Spectrophotometric analysis at baseline, 1 week, 1 and 3 months after material placement
- Application of MTA Fillapex in tooth crowns resulted in minimal color alterations, while Roth 811 induced severe discoloration, *in vitro*
- It could be suggested that, in terms of aesthetics, the use of MTA Fillapex appears to be favorable.

Calcium Phosphate based Sealers

Sankin apatite root canal sealer

- Composed of hydroxyapatite and tricalcium phosphate
- 3 types

Type I

- **Powder**

1. Tricalcium phosphate – 80%
2. Hydroxy apatite – 20%

- **Liquid**

1. Polyacrylic acid – 25%
2. Water – 75%

- Used in vital cases

Type II

- **Powder**

1. Tricalcium phosphate – 52%
2. Hydroxyapatite – 14%
3. Iodoform – 30%

- **Liquid**

1. Polyacrylic acid – 25%
2. Water – 75%

- Used in periapical infection

Type III


- **Powder**

1. Tricalcium phosphate – 80%
2. Hydroxyapatite – 14%
3. Iodoform – 5%
4. Bismuth subcarbonate – 1%

- **Liquid**

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

***In vitro* computer analysis of crown discolouration from commonly used endodontic sealers**

Mandana Partovi dds , ms , Abdol H. Al-Havvaz dds , ms , Banafsheh Soleimani dds

- Crown discolouration by root canal sealers AH26, Endofill, Tubliseal, Zinc oxide eugenol (ZnOE), Apatite root canal sealer III as well as gutta-percha
- The degree of tooth discolouration was analysed at 3, 6 and 9 months
- Conclusion: Endofill and ZnOE caused the greatest discolouration and Apatite root canal sealer III caused the least discolouration after 9 months

Capseal I and II

- Composition

- ***Powder***

- Tetracalcium phosphate
- Dicalcium phosphate anhydrous
- Portland cement (gray cement in type I and white cement in type II)
- Zirconium oxide

- ***Liquid***

- Hydroxypropyl methyl cellulose in sodium phosphate solution

▪ **ADVANTAGES**

1. Less cytotoxicity
2. Potential to promote bone regeneration as root canal sealers
3. Facilitate the periapical healing
4. Good adaption to the canal wall and infiltrates into the dentinal tubules

Adhesion of Sealers to Root Dentin

Root canal sealer adhesion is defined as its capacity to adhere to the root canal dentin and promote GP cone adhesion to each other and the dentin (Sousa-Neto, M.D. et al 2005)



Tagger et al. (2002) argued that the term adhesion should be replaced with bonding in the case of root canal sealers because the attachment between the substances involves mechanical interlocking forces rather than molecular attraction

Adhesion potential is tested using microleakage and bond strength tests

No correlation has been identified between leakage and bond strength (A. Wennberg and D. Orstavik, 1990)



Bond strength is the force per unit area required to debond the adhesive material from the dentin

Dislocation Resistance of iRoot SP, a Calcium Silicate–based Sealer, from Radicular Dentine

[Seyda Ersahan DDS, PhD](#), [Cumhur Aydin DDS, PhD](#)  



- Four different root-canal sealers (iRoot SP, AH Plus [Dentsply DeTrey GmbH, Konstanz, Germany], Sealapex [SybronEndo Corporation, Orange, CA], EndoREZ [Ultradent Inc, South Jordan, UT])
- Bond strengths of iRoot SP (4.15 MPa) and AH Plus (5.31 MPa) were significantly higher than those of Sealapex (0.87 MPa) and EndoREZ (0.71 MPa). There was no significant difference between the bond strength of iRoot SP and AH Plus

Dentin Moisture Conditions Affect the Adhesion of Root Canal Sealers

Emre Nagas DDS, PhD *  , M. Ozgur Uyanik DDS, PhD *, Ayhan Eymirli DDS *,
Zafer C. Cehreli DDS, PhD †, Pekka K. Vallittu DDS, PhD ‡, Lippo V.J. Lassila DDS, PhD ‡,
Veli Durmaz DDS, PhD *

- (1) ethanol (dry), (2) paper points, (3) moist: the canals were dried with low vacuum by using a Luer adapter for 5 seconds followed by 1 paper point for 1 second, and (4) wet: the canals remained totally flooded.
- (1) [AH Plus](#) (Dentsply), (2) [iRoot SP](#) (Innovative BioCeramix Inc, Canada), (3) [MTA](#) Fillapex (Angelus Londrina, Brasil), and (4) [Epiphany](#) (Pentron Clinical Technologies)
- Irrespective of the moisture conditions, iRoot SP displayed the highest bond strength to root dentin.
- Statistical ranking of bond strength values was as follows: iRoot SP > AH Plus > Epiphany ≥ MTA Fillapex.
- The sealers displayed their highest and lowest bond strengths under moist (3) and wet (4) conditions, respectively

The Effect of Prior Calcium Hydroxide Intracanal Placement on the Bond Strength of Two Calcium Silicate–based and an Epoxy Resin–based Endodontic Sealer

Suzan Abdul Wanees Amin BDS, MSc, PhD *  , Reham Saeed Seyam BDS, MSc, PhD * ,
Mohammed Abbas El-Samman BDS, MSc, PhD †

- Filled using the single-cone technique either immediately (the control group, n = 30) or after a 7-day Ca(OH)₂ placement.
- After obturation, a 2-mm-thick middle section of each root was then subjected to push-out testing
- AH Plus (4.26 MPa) showed a higher bond strength than iRoot SP (0.86 MPa) and MTA Fillapex (1.12 MPa) in the control group
- With prior Ca(OH)₂ placement, AH Plus (3.10 MPa) and iRoot SP (3.82 MPa) showed a similar bond strength which was higher than MTA Fillapex (1.72 MPa)

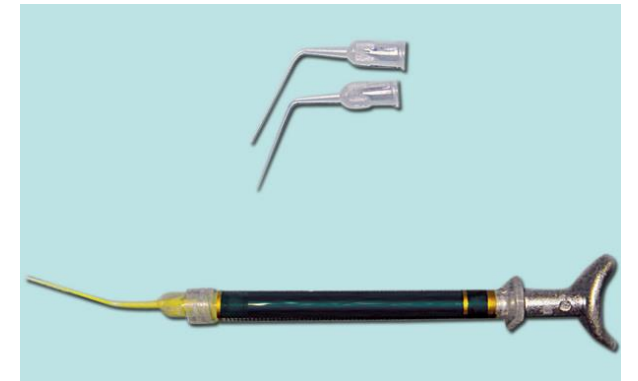
Prior Ca(OH)₂ placement seemed to improve the dislodgment resistance of iRoot SP but did not affect AH Plus and MTA Fillapex

This improvement in bonding is explained the chemical interaction between calcium hydroxide and the iRoot SP sealer increasing the frictional resistance and/or micromechanical retention of the sealer

Sealers Placement

- Various methods of sealer placement have been advocated, including:

1. Master cone
2. Lentulospirals
3. Files
4. Ultrasonics
5. Bidirectional spirals
6. Injecting sealers with syringes



Comparison of Three Different Sealer Placement Techniques: An *In vitro* Confocal Laser Microscopic Study

Using Letulospiral

Size 25 lentulospiral used

Instrument kept up to working length for 5 seconds

Using Bidirectional spiral

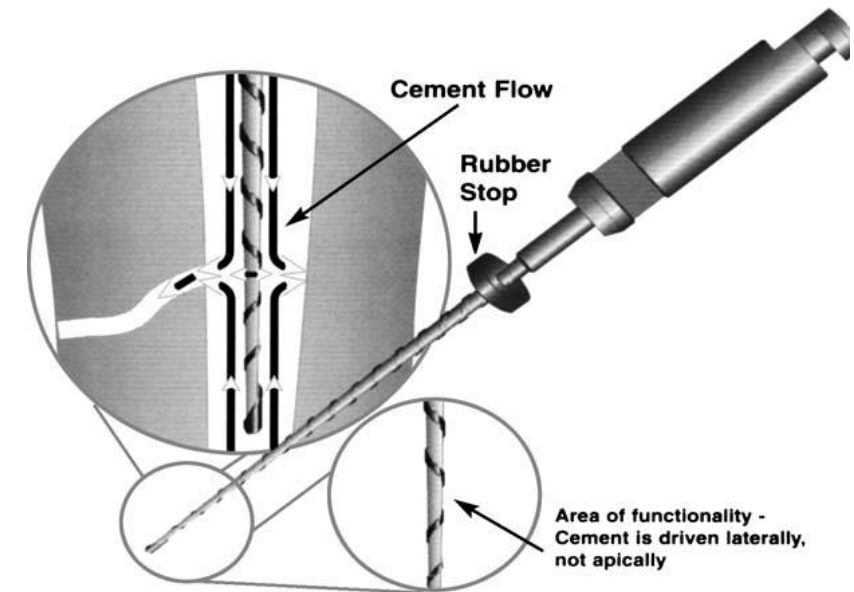
Size 25 bidirectional spiral used

Instrument kept up to working length for 5 seconds

Using Ultrasonic Tip

The ultrasonic endodontic tip K-25 Sonofile used with an Ultrasonic unit for activation of sealer

The file was inserted up to working length inside the canal and was ultrasonically activated for 5 seconds



Lentulo spiral has shown better penetration of sealer than the bidirectional file and ultrasonics
The depth and percentage of sealer penetration was highest coronally which decreased apically

An *in-vitro* evaluation of sealer placement methods

F. H. KAHN, P. A. ROSENBERG, L. SCHERTZER, G. KORTHALS, P. N. T. NGUYEN

- Group 1: absorbent paper point
- Group 2: size 25 K-file
- Group 3: ultrasonically activated size 25 Endosonic file in ultrasonic instrument
- Group 4: sonically-activated size 25 Trisonic file in sonic handpiece
- Group 5: pressure activated, 23 gauge Max-i-Probe Delivery System (MPL Technologies, Franklin Park, IL, USA)
- Group 6: positive control group; lentulo spiral (L.D. Caulk Co.)
- Group 7: negative control group; no sealer was placed

For Groups 1-4 and 6

- Apical 5–6 mm of the carrier was coated by dipping it into the sealer until an even coating was obtained visually
- Same Procedure Repeated again to ensure that it was totally coated with sealer
- After coating of the sealer, the carrier was introduced into the simulated canal 1 mm short of the apical foramen and activated

For Groups 5

- The sealer was placed into the hub of the probe and attached to the pressure-activating system



Sealer Placement Techniques

Group 1, use tweezers to grasp the occlusal end of the paper point, gentle apical-occlusal pumping motion with lateral movement on the canal walls employed for 10 s

Group 2, after file insertion into the canal, rotated counter clockwise for 10 s and withdrawn while rotation continued

Group 3, a size 25 Endosonic file was activated in the canal using an ultrasonic unit, with the irrigation system off, for 10 s, inactivated and withdrawn

Sealer Placement Techniques

Group 4, a size 25 Trisonic file was activated in the canal using a sonic unit, with the water irrigation shut off, for 10 s, inactivated and withdrawn.

Group 5, After inserting the probe into the canal, the cement sealer was expressed by pressing the activation handle while withdrawing slowly from the canal. A paper point was then inserted to the measurement length, and withdrawn from the canal to remove excess sealer

Group 6, the positive control, the lentulo spiral, in a low speed handpiece, was rotated clockwise in the canal at slow speed for 10 s and withdrawn while still rotating

- Lentulo spiral and the Max-i-Probe Delivery System were the most effective means of sealer placement, followed by ultrasonic and sonic files.
- The least effective methods were the paper point and the K file.

Conclusion

- Endodontic sealers play a pivotal role in root canal therapy, contributing to the long term success of the treatment
- Sealers serve to seal off the root canal system, preventing re-infection and promoting healing
- Even though a lot of advancements have taken place in the field of dental materials, an ideal sealer still remains a 'concept'

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Thank You!