Root canal filling materials

Various endodontic materials have been advocated for obturation of the root canal system. Most techniques employ a core material and sealer. Regardless of the core material, a sealer is essential to every technique and helps achieve a fluid-tight seal.
Materials used for root canal obturation are:

1. Root canal sealers
2. Sold or semi-solid filling such as gutta-percha, resilon, or sliver cone Sealers

Sealers: are paste-like materials that are essential to seal the space between the dentinal wall and the gutta-percha.

Functions of the root canal sealer

1. Cementing the core material to the canal wall.
2. Filling and marking irregularities that can not be filled by gutta-percha (lateral and accessory canals).
3. Act as a lubricant to ease the placement of the master cone.
4. Act as a bactericidal agent.

Properties of an Ideal Sealer

1. Exhibits tackiness when mixed to provide good adhesion.
2. Produce a hermetic seal.
3. Radiopaque.
4. Very fine powder to get a smooth mix with the liquid.
5. No shrinkage on the setting.
6. No staining of tooth structure.
7. Bacteriostatic.
8. Exhibits a slow set.
9. Insoluble in tissue fluids.
10. Tissue tolerant.
11. Soluble in common solvents.

Sealers have different types depending **on their composition**:

A. Zinc Oxide Eugenol sealers

Zinc oxide–eugenol sealers have been used for many years. They have certain properties as:



1. It is resorbable if extruded into the peri-radicular region
2. Exhibit a slow setting time.
3. Shrinkage on setting.
4. Solubility.
5. Stain tooth structure.
6. It has antimicrobial activity.

Types of zinc oxide eugenol sealers

1- **Rickert sealer**: is the first formula introduced, which contains powder and liquid. The powder consists of zinc oxide, silver particles, resin, and thymol iodide, while the liquid contains eugenol and Canada balsam. The silver particles are important for antimicrobial properties and radiopacity. However, they stain tooth structure. This sealer can be used with thermoplastic techniques.





2- **Procosol sealer:** It is a modification of Rickert's formula in which the silver particles have been removed.

3- **Roth's sealer:** This is a modification of the Rickert' sealer as it is non-staining.



4- **<u>Tubli-Seal</u>** is a catalyst/base zinc oxide–eugenol sealer. It has a faster setting time than liquid/powder sealers.



B. Noneugenol Sealers.

They are root canal sealers without the irritating effects of eugenol, eg; Nogenol.



C. Calcium Hydroxide Sealers.

They were developed for their antimicrobial activity and osteogenic–cementogenic potential due to the presence of CaOH. However, research has found that these actions were very limited, because of the inability of these sealers to sustain a high pH over time on the root canal surface. Examples of this group are Sealapex (catalyst/base system), Apexit and Apexit Plus.



D. Glass Ionomer Sealers.

The glass ionomers have been developed in root canal obturation because of their dentin-bonding properties. An example from this group is Ketac-endo.

Properties of this group:

1. It enables adhesion between the material and the canal wall.
2. It is difficult to properly treat the dentinal walls in the apical and middle thirds with conditioning agents to receive the glass ionomer sealer.
3. A disadvantage of glass ionomers is that they are more difficult to remove if retreatment is required.
4. It has minimal antimicrobial activity.



E. Resin sealers.

These sealers were developed to provide adhesion, and do not contain eugenol. There are two major categories: epoxy resin and methacrylate resin.



1. Epoxy resin sealers:

a) **<u>Ah-26:</u>** It is a slow-setting epoxy resin that releases formaldehyde when setting.



b) **<u>Ah Plus:</u>** It is a modified formulation of Ah-26 in which formaldehyde is not released. It exhibits a working time of approximately 4 hours.

2. Methacrylate resin sealers:

Following the marketing of self-priming, self-etching, and self-adhesive resin cement technologies in restorative dentistry, low-viscosity methacrylate resin-based root canal sealers have since been available for use in endodontics. Since then the term monoblock has started to be used which means perfectly filled root canal space with a gap-free, solid mass that consists of different materials and interfaces, with the purported advantages of simultaneously improving the seal and fracture resistance of an obturated RCS. Examples of this type:



a) **<u>EndoREZ:</u>** It is a dual-cure methacrylate resin with hydrophilic properties. It is designed to flow into accessory canals and dentinal tubules to facilitate resin tag formation for retention and seal after smear layer removal with NaOCl and EDTA. When using endoREZ with resin-coated gutta-percha cones, the sealer bonds to both the canal walls and the core material.

b) **Diaket:** It is a polyvinyl resin sealer initially intended for use as a root-end filling material. It has better sealing ability when compared with other root-end filling materials. The biocompatibility of Diaket has been reported to be higher when mixed with a thicker consistency advocated for use as root-end filling material.



c) **Fourth-generation methacrylate resin-based sealers (e.g., MetaSEAL and RealSeal)**: are functionally analogous similar to self-adhesive resin luting cements that contain acidic monomers. This can cause self-adhesion of the sealer to the dentin substrate without the need for different steps of etching and priming.





Epiphany is another resin-based sealer composed of resilon and used with the Resilon root filling material.



F. Silicone Sealers.

1. **RoekoSeal:** is a polyvinylsiloxane that is reported to expand slightly on the setting.



2. **<u>GuttaFlow and GuttaFlow 2</u>**; is a cold flowable matrix that is triturated. It consists of gutta-percha in a particular form which is added to roekoSeal. The material comes in a capsule that can be injected into the root canal followed by the placement of a single master cone. Sealing ability is comparable to other techniques.





G. Bioceramic sealers.

It is composed of zirconium oxide, calcium silicates, calcium phosphate monobasic, calcium hydroxide, and various filling and thickening agents.
Properties of this group:

1. It is a hydrophilic sealer that utilizes moisture within the canal to complete the setting reaction.
2. It does not shrink on the setting.
3. It has bioactive properties which induce periapical cells (cementoblast and osteoblast) to regenerate the periapical tissue.
4. It exhibits antimicrobial properties during the setting reaction.

Examples for this type; BioRoot RCS (Septodont, France), iRoot SP (Innovative BioCeramix Inc., Vancouver, Canada), Total Fill BC Sealer (FKG, Switzerland).

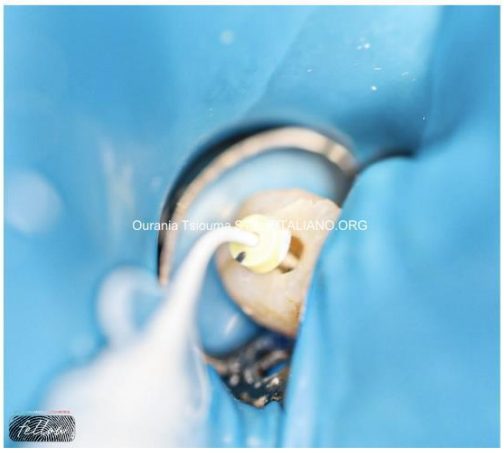
Methods for placement of root canal sealer:

1- Maser cone: Coat the master cone with sealer and slowly insert it to the full working length. This approach might be insufficient in oval or wide canals.



2- Lentulo spiral or a file and/or reamer: these can be used either manually or by using a rotary device to place the sealer inside the root canal through a counter-clockwise motion until the sealer becomes visible at the canal orifice.
3- The technique that is most recommended is the injection of the sealer into the canal with a flexible cannula capillary tip connected to the sealer syringe. It comes with Bioceramic sealers. The sealer should be injected first until it comes out from the tip of the plastic cannula to remove any trapped air. The syringe tip is then placed in the canal at the level of the coronal or middle third and the sealer is injected until it comes out of the canal orifice. This is followed by inserting the master cone until reaches the full working length.





Semi-rigid types materials for obturation of the root canal

1. <u>Gutta-Percha:</u>

It is a linear crystalline polymer that melts at a set temperature, with a random but distinct change in structure resulting. It occurs naturally as 1,4- polyisoprene and is harder, more brittle, and less elastic than natural rubber.



The crystalline phase has two forms, the alpha phase and the beta phase. The alpha form is the material that comes from the natural tree product. The processed, or beta, form is used in gutta-percha for root fillings.
When heated, gutta-percha undergoes phase transitions. The transition from the beta phase to the alpha phase occurs at around 46° C. An amorphous phase develops at around 54° C to 60° C. When cooled very slowly gutta-percha crystallizes to the alpha phase. Normal cooling returns the gutta-percha to the beta phase. Gutta-percha cones soften at a temperature above 64° C.
These cones can easily be dissolved in many solvents as chloroform, halothane, and xylene. Modern gutta-percha cones that are used for root canal fillings contain only about 20% gutta-percha. The major component is zinc oxide (60% to 75%), and the remaining 5% to 10% consists of various resins, waxes, and metal sulfate.
Although GP points cannot be heat sterilized, gutta percha points can be sterilized by placing them in 5.25% NaOCl for 1 minute. Also, other antimicrobial agents can be used such as; 2% glutaraldehyde, 2% chlorhexidine, and 70% ethyl alcohol, however, they are not as effective as NaOCl.
Pressure applied during root canal filling procedures does not compress gutta-percha but rather compacts the gutta-percha cones to obtain a more three-dimensionally complete fill of the root canal system. Also, compaction of heat-treated gutta percha can compensate for the slight shrinkage after cooling (approximately 1% to 2%) when the gutta-percha has solidified.
Gutta-percha cannot be used alone as a filling material; because it lacks the adherent properties necessary to seal the root canal space. Therefore, a sealer is always needed for the final seal. Gutta-percha cones are available in different tapers ISO tapering 0.02% and the larger taper matching rotary instruments such as 0.04%, and 0.06%.

Advantages of gutta-percha

1. Inert
2. Dimensional stability
3. Non-allergic

4. Non-staining to dentin
5. Radiopaque
6. Compactable
7. Softened by heat
8. Softened by organic solvents

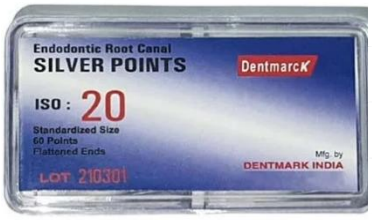
Disadvantages of gutta-percha

1. Lack of rigidity
2. No adherence to dentin
3. No complete adaptation to narrow areas.

2. Resilon

It is a thermoplastic, synthetic, polymer-based root canal filling material. It was developed to create an adhesive bond between the solid-core material and the sealer (Epiphany). Resilon can be supplied in the same ISO sizes and shapes (cones and pellets) as gutta-percha. When manufactured in cones, Resilon's flexibility is similar to that of gutta-percha. Based on polyester polymers, Resilon contains bioactive glass and radiopaque fillers (bismuth oxychloride and barium sulfate) with a filler content of approximately 65%. It can be softened with heat or dissolved with solvents such as chloroform. However, research found that Resilon material is not stable and breaks down within the tooth over time, presumably due to enzymatic degradation which appears to negatively affect the long-term success of teeth obturated with this material and it was withdrawn from the market in 2014.

Solid-type materials for obturation of the root canal



1. **Semi-rigid materials**: as silver cones which are not used now. They are flexible and fill narrow curved root canals. When silver cones contact tissue fluids or saliva, they corrode. The corrosion products are cytotoxic.
2. **Rigid materials** such as Vitallium cones or implants, which are inflexible and were used as endodontic implants.