Root canal filling materials

Sealers

They are paste like material that is 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 cannot 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 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 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.

Zinc Oxide and Eugenol

Zinc oxide- Eugenol sealers have been used for many years. They have certain properties as:

1- Exhibit a slow setting time.
2- Shrinkage on setting.
3- Solubility especially when extruded outside the root canal.
4- Stain tooth structure.
5- It has antimicrobial activity.

Types of Zinc Oxide and Eugenol Sealer

Types of zinc oxide eugenol sealers

1- Rickert sealer. This powder/liquid sealer contains silver particles for radiopacity. It stains tooth structure if not completely removed. This sealer is popular when using 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's sealer as it is nonstaining.
4- Tubli-Seal. It is a catalyst/base zinc oxide-eugenol sealer. It has a faster setting time when compared with the liquid/powder sealers.

Calcium Hydroxide Sealers

They were developed for their antimicrobial activity and osteogenic-cementogenic potential. These actions were very limited. From the types of this group are Sealapex (catalyst/base system), Apexit and Apexit Plus.

Noneugenol Sealers

They are root canal sealers without the irritating effects of eugenol.

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 modifying agents to receive the glass ionomer sealer
3- It has minimal antimicrobial activity.

Resin sealers

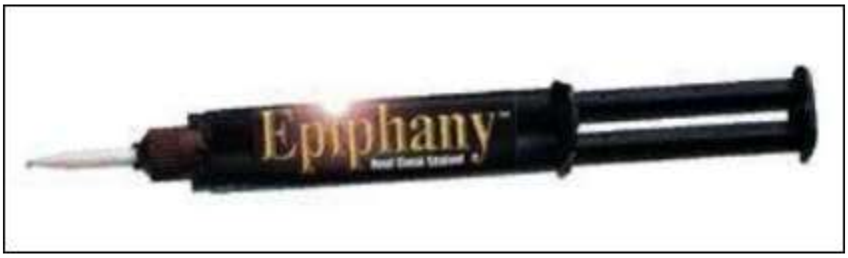
These sealers provide adhesion, and do not contain eugenol.

Types of this group are:

1- Ah-26 slow-setting epoxy resin that releases formaldehyde when setting.
2- Ah plus. It is a modified formulation of Ah-26 in which formaldehyde is not released. It exhibits a working time of approximately 4 hours.

3- EndoREZ. It is a methacrylate resin with hydrophilic properties. When used with endoREZ resin-coated gutta-percha cones the dual cure endoREZ sealer bonds to both the canal walls and the core material.

4- Diaket. It is a pollvinyl resin sealer.
5- Epiphany and RealSeal. They were introduced for use with the resilon filling material.



Silicone Sealers

1- RoekoSeal is a polyvinylsiloxane that is supposed to expand slightly on setting.

2- GuttaFlow is a cold flowable matrix that is triturated. It consists of guttapercha added to roekoSeal. Sealing ability is comparable to other techniques.

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 it utilizes moisture within the canal to complete the setting reaction.
2- It does not shrink on setting.
3- It is biocompatible.
4- It exhibits antimicrobial properties during the setting reaction.

Semi Rigid types materials for obturation of the root canal

1- Gutta-Percha

Gutta-percha is the most commonly used root canal filling material. 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 beta phase to 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%). The remaining 5%to 10% consists of various resins, waxes, and metal sulfate.

Antiseptic guffa-percha with various antimicrobial agents as chlorhexidine and calcium hydroxide may be seen. Gutta-percha cannot be heat sterilized; therefore NaOCI can be used to disinfect the cones by dipping them for 1 minute. Pressure applied during root canal filling procedures does not compress gutta-percha, but rather compact the gutta-percha cones to obtain a more three-dimensionally complete fill of the root canal system. After heating, while cooling, there is a slight shrinkage of approximately 1% to 2% when the gutta-percha has solidified. Gutta-percha cannot be used alone as a filling material; it lacks the adherent property necessary to seal the root canal space. Therefore, a sealer is always needed for the final seal. Gutta-percha cones are available in tapers matching the larger tapered rotary instruments (#.02, #.04, and #.06).

Advantages of gutta percha

1- Inert
2- Dimensional stability
3- Non allergic
4- Antibacterial
5- Non staining to dentin
6- Radiopaque
7- Compactable
8- Softened by heat
9- 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. Resilon can be supplied in the same ISO sizes and shapes (cones and pellets) as guttapercha. When manufactured in cones, Resilon's flexibility is similar to that of guttapercha. 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.

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 as Vitalium cones which are inflexible and were used as endodontic implants.

Obturation of the root canal system

Objectives of canal obturation

1- Prevention of percolation of periapical exudates into the root canal space.
2- Prevention of reinfection of the root canal during transient bacteremia.
3- Creation of a favorable biological environment for the process of tissue healing.

Criteria for root canal obturation

1. Asymptomatic tooth.
2. Dry canal.
3. No sinus tract.
4. No foul odor.
5. Negative culture.

Heat softened gutta percha techniques

Warm lateral condensation

This technique depends on a heated spreader to soften the gutta percha during lateral condensation to improve the adaptation of the gutta percha to the wall of the root canal.

<u>Technique:</u>

1- Heating the spreader is done by hot glass beads which are then inserted in the root canal.
2- Lateral condensation is done to create space for the accessory cones.
3- This procedure is repeated until the canal is completely filled.
4- An electrically heated spreader may be used.

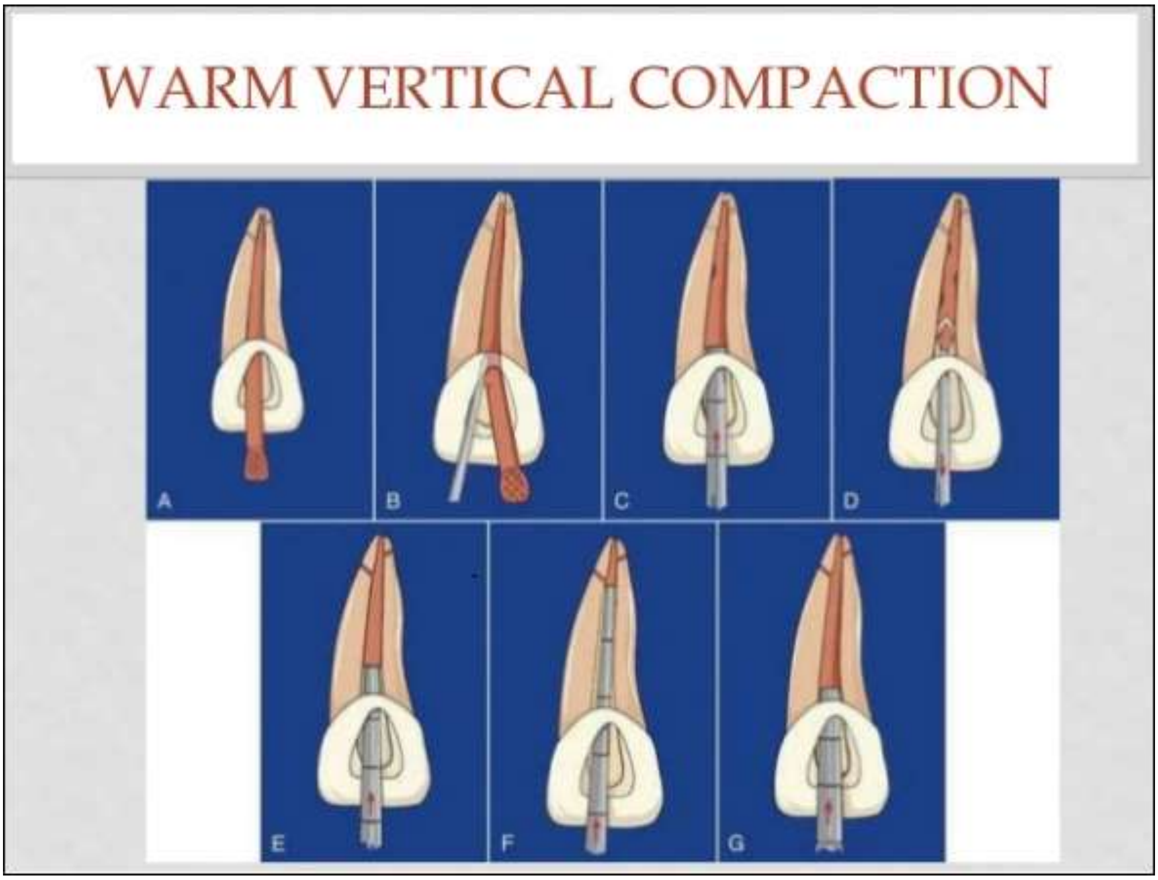
Warm vertical gutta percha filling technique

It is a method of filing the radicular space in three dimensions. The canal should be with a continuously tapering funnel and keeping the apical foramen as small as possible. The armamentarium includes a variety of pluggers and a heat source.

<u>Technique:</u>

1- The master cone should fit short of the corrected working length (0.5 to 2 mm) with resistance to displacement. This ensures that the cone diameter is larger than the prepared canal.

2- After the adaptation of the master cone it is removed and sealer is applied in the root canal.
3- The cone is placed in the canal and a heated spreader or plugger is used to remove portions of the coronal gutta-percha and soften the remaining material in the canal.
4- A plugger is inserted into the canal and the gutta-percha is compacted, forcing the plasticized material apically.
5- The process is repeated until the apical portion has been filled.
6- The coronal canal space is backfilled, using small pieces of gutta-percha. The sectional method consists of placing 3-4 mm sections of gutta-percha approximating the size of the canal into the root, applying heat, and compacting the mass with a plugger.



Continuous Wave Compaction Technique

It is a variation of warm vertical compaction. The manufacturing of cones to resemble the tapered preparation using rotary instrumentation permits the application of greater hydraulic force during compaction when appropriately tapered pluggers are used.

<u>Technique:</u>

1- After selecting an appropriate master cone, a plugger is prefitted to fit within 5 to 7 mm of the canal length.

2- The heat source (ex. System B unit) is set to 200° C.
3- The plugger is inserted into the canal orifice when the master cone is present in the root canal and activated to remove excess coronal material.

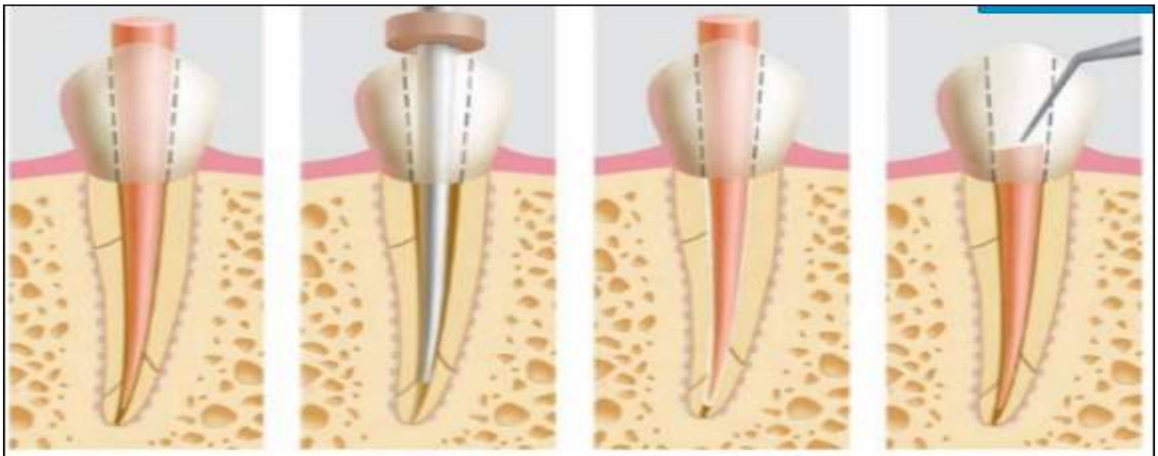


Figure 1: Fit master cone in a wet canal, adjust cone to 0.5mm short of working length

Figure 2: Pre-fit a System B Cordless Pack Tip, adjust to fit 4-6mm short of the terminus

Figure 3: Coat the cone with sealer

Figure 4: Using the System B Pack, sear the cone off at the orifice level

4- Compaction is initiated by placing the cold plugger against the gutta-percha in the canal orifice.
5- Firm pressure is applied and heat is activated with the device. The plugger is moved rapidly (1 to 2 s) to within 3 mm of the binding point.

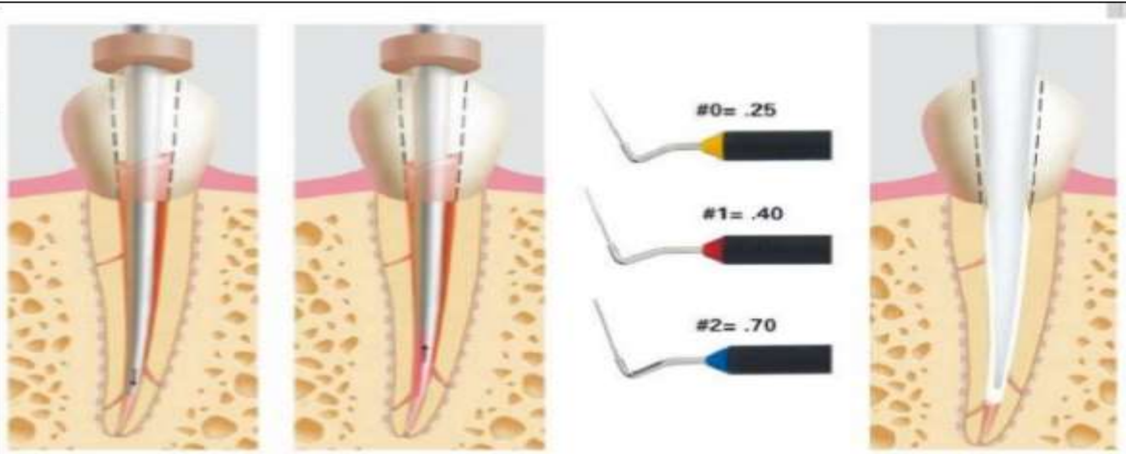


Figure 5: Set the Pack tip on the cone; activate the heat switch and downpack, continue applying apical pressure whilst the cone cools

Figure 6: Re-activate the System B Pack to separate the Pack Tip from the cone

Figure 7: Use the appropriate Buchanan hand plugger to condense the apical fill

Figure 8: Lightly place more sealer in the backfill space

6- The heat is inactivated while firm pressure is maintained on the plugger for 5 to 10 seconds.
7- After the gutta-percha mass has cooled a 1 second application of heat separates the plugger from the gutta-percha, and it is removed.

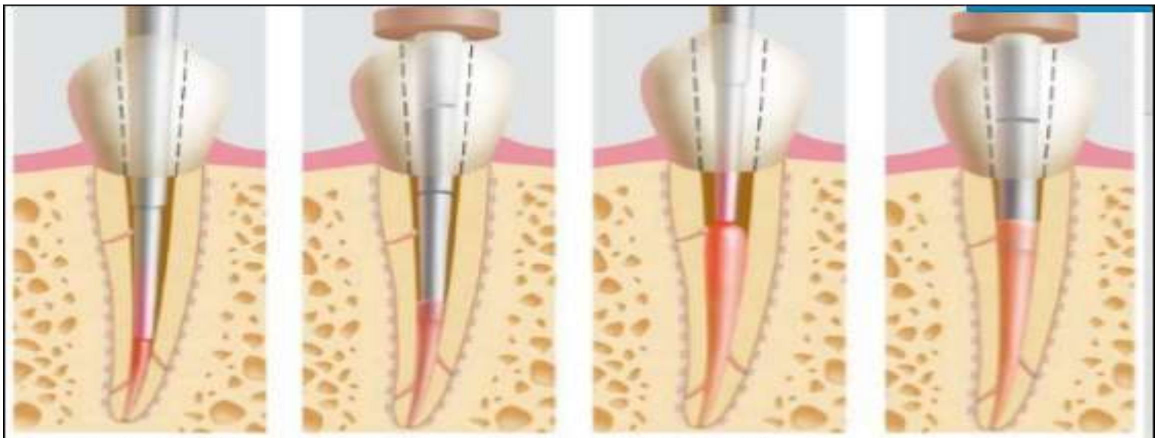


Figure 9: Place the System B Fill needle in the canal short of the of the apical fill. Backfill the canal half way. Use the hand plugger to condense the fill

Figure 10: Repeat stage 9 to backfill the coronal half of the backfill space

Thermoplastic Injection Techniques

Heating of gutta-percha outside the tooth and injecting the material into the canal is an additional variation of the thermoplastic technique. This technique is used to obturate irregularities difficult to fill by other techniques as internal resorption. The obtura III, Calamus, Ultradent and Guttaflow devices and systems are examples of this type.

<u>Technique:</u>

1- Canal preparation is similar to other obturation techniques and the apical foramen should be as small as possible to prevent extrusion of gutta-percha.

2- The canal walls are coated with sealer using the master apical file.
3- A gutta-percha pellet is preheated in the gun, and the needle is positioned in the canal so that it reaches within 3 to 5 mm of the apical preparation.
4- Gutta-percha is then gradually, passively injected by squeezing the trigger of the gun.
5- The needle backs out of the canal as the apical portion is filled.
6- Pluggers dipped in alcohol are used to compact the gutta-percha. Compaction should continue until the gutta-percha cools and solidifies to compensate for the contraction that takes place on cooling.
7- Both overextension and underextension are common results.

Carrier-Based Gutta-Percha

Thermafil and Soft Core cones were introduced as a gutta-percha obturation material with a solid core. The technique has a central plastic core which facilitates the adaptation of the α-phase gutta percha to the root canal walls apically and laterally.

Advantages included ease of placement and the pliable properties of the gutta-percha.

<u>Technique:</u>

1- Size verifiers should fit passively at the corrected working length.
2- After drying the canal a light coat of sealer (Grossman sealer) is applied and a carrier is marked, set to the predetermined working length.
3- Removal of the smear layer is strongly recommended because it enhances the seal.
4- The carrier is disinfected with 5.25% NaOCI for 1 minute and rinsed in70% alcohol.
5- The carrier is then placed in the heating device to the specified temperature.

6- When the carrier is heated, it has approximately 10 seconds to be inserted it into the canal. This is accomplished without rotation or twisting.
7- The position of the carrier is verified radiographically.
8- The gutta-percha is allowed 2 to 4 minutes to cool before resecting the coronal portion of the carrier.
9- Vertical compaction of the coronal gutta-percha can be accomplished.
10- An advantage to this technique is the potential for movement of gutta-percha into lateral and accessory canals but extrusion of material beyond the apical extent of the preparation is a disadvantage.

Solvent Techniques

Gutta-percha can be plasticized with solvents such as chloroform, eucallptol, and xylol. A gutta-percha cone is softened and placed into the canal to adapt better to the root canal wall; the mass hardens as the solvent evaporates. Disadvantages of this technique include:

1- Shrinkage occurs with the evaporation process causing voids.
2- Irritation of periradicular tissues by the solvent.

Pastes

Pastes have some requirements of the root canal obturating materials. They can adapt to the complex internal canal anatomy; however, the flow characteristic can result in extrusion or incomplete obturation. Some pastes are toxic because they include paraformaldehyde therefore they are not used now.

Apical foramen Obturation

Apical barriers (arrow in radiograph) may be necessary in cases with immature apical development, external apical root resorption and where instrumentation extends beyond the confines of the root.

There are several materials that can seal the apical area of the root canal as dentin chips, calcium hydroxide, demineralized dentin, lyophilized bone, tricalcium phosphate, hydroxyapatite, and collagen. The barriers are designed to permit obturation without extrusion of materials into the periradicular tissues but are often incomplete and do not seal the canal.

1- Dentin chips. It is taken from shaving the internal wall of the root canal after instrumentation. It is applied in the apical end of the root canal to act as a biologic seal to enhance healing. Contaminated dentin with bacteria decreases the success of the treatment.

2- Calcium hydroxide. It is extensively used as a common apical barrier. Calcium hydroxide has been shown to induce an apical barrier in apexification. It is free of bacterial contamination and may provide a better but imperfect apical seal. It enhances healing by inducing cementum and bone formation.

3- Mineral trioxide aggregate (MTA). It has been successfully employed as an apical barrier material before obturation. MTA is sterile, biocompatible, and capable of inducing hard tissue formation.

   Technique.

   a. After the cleaning and shaping procedures the canal is dried and MTA is placed.
   b. The material is compacted into the apical portion of the root to form a barrier.
   c. After the material sets, gutta-percha can then be compacted without extrusion.

4- Pulp regenerative techniques including revascularization. This technique aims to regenerate the vitality of the pulp to increase thickness of the canal walls and induce apical root development and apex.

   Technique:

a) Copious irrigation.
b) Minimal canal preparation.
c) Use of an antibiotic paste as an interim medication.
d) At the next visit bleeding is induced in the canal to induce a clot that is covered with MTA.
e) When the MTA is set a definitive restoration can be placed to ensure a coronal seal.