Root canal filling materials

Sealers:

Root canal sealers are necessary to seal the space between the dentinal wall and the obturating core interface. Sealers also fill voids and irregularities in the root canal, lateral and accessory canals, and spaces between gutta-percha points used in lateral condensation. Sealers also serve as lubricants during the obturation process.

Properties of an Ideal Sealer:

Grossman outlined the properties of an ideal sealer. At present no sealer satisfies all the criteria.

- ♦ Exhibits tackiness when mixed to provide good adhesion between it and the canal wall when set
- ♦ Establish a hermetic seal
- ♦ Radiopaque, so that it can be seen on a radiograph
- ♦ Very fine powder, so that it can mix easily with liquid
- ♦ No shrinkage on setting
- ♦ No staining of tooth structure
- ♦ Bacteriostatic, or at least does not encourage bacterial growth
- ♦ Exhibits a slow set
- ♦ Insoluble in tissue fluids
- ♦ Tissue tolerant; that is, nonirritating to periradicular tissue
- ♦ Soluble in a common solvent if it is necessary to remove the root canal filling

Types of root canal sealers:

In general, the four major types of sealers are zinc oxide–eugenol based, resin based (epoxy resin or methacrylate resin) sealers, glass ionomer, and those containing calcium hydroxide. Other variations and compounds have been proposed or are marketed as sealers; these should be considered experimental. Regardless of the sealer selected, all exhibit toxicity until they have set. For this reason, extrusion of sealers into the periradicular tissues should be avoided.

- **Zinc oxide–eugenol sealers**

Zinc oxide–eugenol (ZnOE) sealers have been used for many years and ample clinical experience exists with these materials. However, sealing ability and biological

properties are, in general, inferior compared with other root canal sealers. Because of its tendency for disintegration ZnOE is still recommended as a root canal filling material for deciduous teeth. However, it has not been shown that disintegration of the material occurs parallel to tooth resorption. Formaldehyde-releasing ZnOE root canal sealers should not be used any more because of their inherent toxic potential. The European Society of Endodontology discourages the use of these materials.

- **Resin based sealers:**

- **Epoxy resin sealers**

Epoxy resin sealers have comparatively good mechanical and sealing properties. No effects on general health are expected and allergic reactions are apparently rare. Antimicrobial properties are good, especially in a freshly mixed state. Cytotoxicity is moderate to low (set state). Mutagenicity is mainly observed shortly after mixing and no unacceptable risk is expected for the patient. For dental personnel, a "no touch technique" is recommended.

- **Methacrylate resin sealers**; are not commonly used.

- **Glass Ionomer sealers**

Endodontic formulations of glass ionomer have been introduced recently. This material has the advantage of bonding to dentin, seems to provide an adequate apical and coronal seal, and is biocompatible. However, its hardness and insolubility make retreatment and post space preparation more difficult, and it is difficult to treat the dentin properly to accept the material.

- **Calcium hydroxide sealers**

Calcium hydroxide sealers have inferior technical properties compared with epoxy resin preparations. Leakage studies show inconsistent results, with a tendency for poorer sealing quality compared with other sealers. From a biological point of view, calcium hydroxide sealers are very favorable materials and they exhibit– at least in a freshly mixed state – considerable antimicrobial activity. Furthermore, they belong to the few materials that apparently support apical healing and hard-tissue formation (root-end closure).

- **Mineral trioxide aggregate (MTA)**

This cement was introduced in 1993, as a root-end filling material for sealing of communications between the root canal system and the periapical tissue. The cement, similarly to calcium hydroxide, supports hard-tissue repair at root ends as well of pulpal exposures and has therefore also been used for apexification in root-open teeth and for pulp capping and pulpotomy procedures. A new category of root canal sealers based on mineral trioxide aggregate (MTA) has recently been commercially available. These sealers are an outgrowth of the popularity of MTA materials, which are based on tricalcium silicate, a hydraulic (water setting) powder used for various surgical and vital pulp therapy treatments. This type of root canal sealer is attractive because of the bioactivity that has been reported for MTA-type materials, which are also known for being hydrophilic.

- **Silicone Sealers**

RoekoSeal (Coltène/Whaledent) is a polydimethylsiloxane that has been reported to expand slightly on setting. GuttaFlow and GuttaFlow2 (Coltène/Whaledent) are cold flowable matrices that are triturated. They consist of gutta-percha in particulate form (less than 30 μm) added to RoekoSeal. The technique involves injection of the material into the canal, followed by placement of a single master cone. The material provides a working time of 15 minutes and it cures in 25 to 30 minutes. Evidence suggests that the material fills canal irregularities with consistency and is biocompatible, but the setting time is inconsistent and may be delayed by final irrigation with sodium hypochlorite.

- **Ceramic-Based Sealer**

Ceramic-based sealer is a recently introduced root canal sealer. It is based on a bioceramic composition with zirconium oxide, calcium silicates, calcium phosphate, and calcium hydroxide as its main constituents, besides fillers and thickening agents. The sealer has been reported as insoluble, radiopaque, and nonshrinking; it requires moisture to harden (hydrophilic). Studies have shown that bioceramic sealer has minor cytotoxicity. However, further studies are necessary to determine the long-term effect of this sealer on the success of the treatment.

SEALER MIXING & PLACEMENT

ZnOE sealer types should be mixed to a thick consistency. The thicker the mix, the better the properties of the sealer, particularly in regard to stability, superiority of seal, and diminished toxicity. Epoxy resins are mixed to a much thinner consistency.

Various techniques have been advocated for placement of sealer, which is done before insertion of the core material. The sealer may be placed with paper points, with files, with ultrasonic activation of files, with special drills (lentulo), as a coating on the primary cone, or by injecting with special syringes. Although different methods have shown varying degrees of effectiveness in sealer application, no technique has proved superior.

- **Core obturating materials:**

Properties of an Ideal Obturation Material

♦ Easily manipulated and provides ample working time
♦ Dimensionally stable with no shrinkage once inserted
♦ Seals the canal laterally and apically, conforming to its complex internal anatomy
♦ Nonirritating to the periapical tissues
♦ Impervious to moisture and nonporous
♦ Unaffected by tissue fluids—no corrosion or oxidization
♦ Inhibits bacterial growth
♦ Radiopaque and easily discernible on radiographs
♦ Does not discolor tooth structure
♦ Sterile
♦ Easily removed from the canal if necessary

Silver Cones

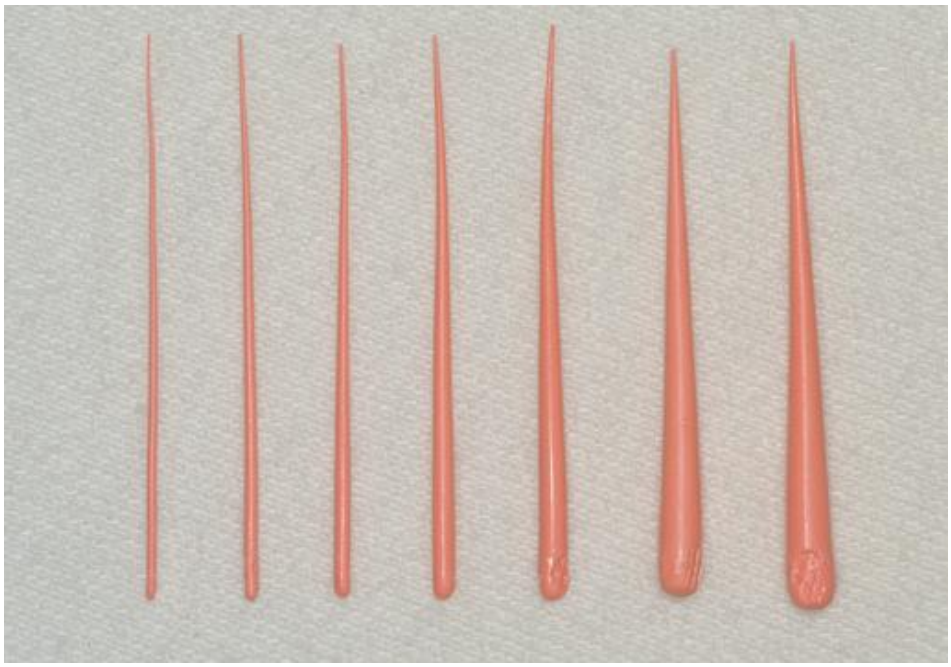
Jasper introduced cones made of silver, which he claimed produced the same success rate as gutta-percha and were easier to use. The rigidity provided by the silver cones made them easier to place and permitted more predictable length control; however, their inability to fill the irregularly shaped root canal system permitted leakage. Silver cones were believed to possess an oligodynamic property which, if true, would have resulted in the destruction of microbes within the root canal system. Unfortunately, it was not

true. Moreover, when silver points contact tissue fluids or saliva, they corrode. The corrosion products have been found to be cytotoxic and produce pathosis or impede periapical healing. With the introduction of rigid silver cones it became possible to easily place them to length. This resulted in clinicians often failing to properly clean and shape the canal before obturation. Treatment failures were the result of leakage and failure to remove the irritants from the root canal system. The use of silver cones today is considered to be below the standard of care in contemporary endodontic practice.

Gutta-Percha

Gutta-percha is the most popular core material used for obturation. The major advantages of gutta-percha are its plasticity, ease of manipulation, minimal toxicity, radiopacity, and ease of removal with heat or solvents. Disadvantages include its lack of adhesion to dentin and, when heated, shrinkage upon cooling. Gutta-percha is the *trans*-isomer of polyisoprene (rubber) and exists in two crystalline forms (α and β). In the unheated β phase, the material is a solid mass that is compactable. When heated, the material changes to the α phase and becomes pliable and tacky and can be made to flow when pressure is applied. A disadvantage to the α phase is that the material shrinks on setting. Gutta-percha cones consist of approximately 20% gutta-percha, 65% zinc oxide, 10% radio-pacifiers, and 5% plasticizers. Attempts have been made to make gutta-percha more antimicrobial by the addition of materials such as iodoform, calcium hydroxide, chlorhexidene, and tetracycline. The clinical effectiveness of adding these materials has not been demonstrated. Moreover, to exert an antimicrobial pharmacological effect, the active ingredient must leach out of the gutta-percha, which could have a detrimental effect on long-term sealability.

Although gutta-percha points cannot be heat sterilized, a study reported that gutta-percha points can be sterilized by placing in 5.25% NaOCl for one minute. Gutta percha has two basic shapes: the "standardized" and the non-standardized. Standardized cones are designed to have the same size and taper as the corresponding endodontic instruments. That is, a No. 40 cone should correspond to a No. 40 file. The non-standarized cones use a different sizing system. The tip of the cone has one size and the body of the cone another. They are available in various combinations.



Nonstandard gutta-percha cones: extra fine, fine fine, fine, medium fine, fine medium, medium, large, and extra large.

Resilon:

Resilon is a high-performance industrial polyester that has been adapted for dental use. The resin sealer bonds to a Resilon core, and attaches to the etched root surface. The manufacturer claims that this forms a "monoblock" . With traditional obturation techniques, there is a gutta-percha–sealer interface and a tooth sealer interface. With Resilon the resin sealer bonds to both the canal wall and the Resilon cone. Whether a monoblock is achievable remains controversial. The system resembles gutta-percha and can be placed by lateral compaction, warm lateral or vertical compaction, thermoplastic injection, or with a core-carrier technique. It consists of a resin core material (Resilon) composed of polyester, difunctional methacrylate resin, bioactive glass, radiopaque fillers, and a resin sealer. Resilon is nontoxic, nonmutagenic, and biocompatible. The core material is available in nonstandard and standard cones and pellets for use in thermoplastic techniques.

Epiphany system with the primer, thinning resin, sealant, and standard **Resilon points**.

Costum cones

Although standardized cones are available from size 15 (0.15 mm) to 140 (1.40 mm), occasionally a canal is encountered that exceeds these dimensions. In such cases a customized gutta-percha point can be created by rolling several warmed gutta-percha points together between two glass slabs or with a cement spatula on a glass slab. The point is cooled with water and the size is tested in the canal and rerolled until an approximate fit is achieved. Solvent dip may then be used to further adapt it to the walls of the canal. Sealer and accessory points can then be used.