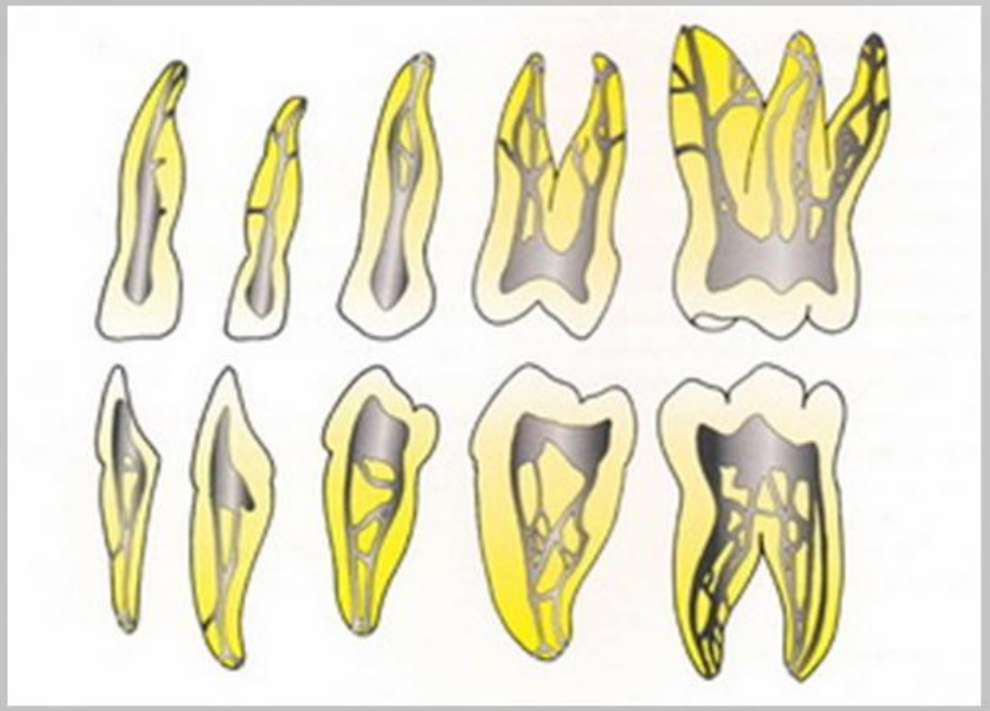
KAZAN STATE MEDICAL UNIVERSITY
Faculty of Dentistry
Department of Therapeutic Dentistry

MATERIALS FOR ROOT CANAL FILLING



Requirements for materials for dental root canal filling

Biological requirements

Biocompatibility with surrounding living tissues and the body as a whole:

1. no irritant effect on periodontal tissues
2. bactericidal effect
3. bacteriostatic effect
4. a certain stimulating effect on regeneration processes in periodontal tissues

Physical and chemical requirements

1. no shrinkage during curing
2. have a constant volume in the cured state
3. cure slowly or permanently
4. not dissolve under the influence of tissue fluids and be impermeable to them
5. Do not stain the dental hard tissue or the tooth as a whole
6. have adhesive properties to the walls of the root canal, i.e. to the dentin of the root canal

Technological (manipulation) properties

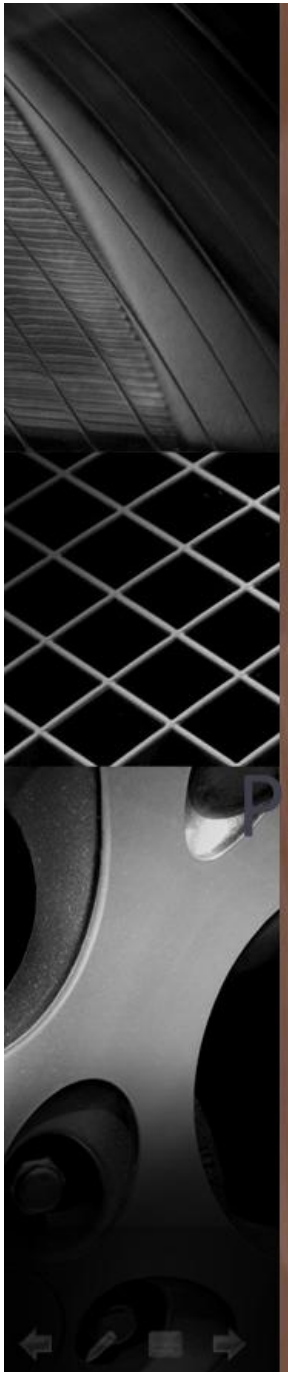
1. ability to easily insert into a microfine canal (0.5-1.7 mm diameter at the orifice and 0.3-1.0 mm at the apex-apex)
2. ability to fill the root canal without voids, if necessary, easily removed from the canal
3. X-ray contrast

Types of filling materials for root canals

1. Plastic

- non-curing or slowly (more than 72h) curing pastes
- hardening materials, primarily cements

2. Primary solids



Plastic non-hardening filling materials

Plastic non-hardening filling materials

The active ingredient in these materials may be:

- calcium hydroxide
- antibiotics
- Sulfonamides
- metronidazole
- antiseptics
- corticosteroids

The fillers of these materials can be:

- zinc oxide
- white clay
- Vaseline
- glycerin
- aromatic oils.

Properties of non-hardening plastic materials

- osteotropic
- bactericidal
- antiseptic
- anti-inflammatory

Disadvantages of non-hardening plastic materials

1. do not harden in the canal
2. permeable to tissue fluid
3. dissolve in the canal
4. do not provide airtight isolation of the periodontium from the root canal lumen

Indications for the use of non-hardening plastic materials

- Temporary filling of root canals for the treatment of periodontitis
- The effect of the active ingredient (depending on the composition) can last from a few days to two 2 months.

Materials for temporary filling of tooth canals

Antibiotic and corticosteroid-based pastes

Septomixin Forte

Composition:

- Dexamethasone
- Polymyxin B sulfate
- Tyrotricin
- Neomycin Sulfate
- Filler

Effectively suppresses microflora, avoiding the formation of antibiotic-resistant strains

Dexamethasone reduces inflammatory and allergic reactions

Metronidazole-based pastes

Crenosol

Composition:

- Metronidazole
- Propyl parahydroxybenzoate
- Methyl parahydroskienzoate
- Glycerol monostearate
- Glycerol

Used in the treatment of heavily infected root canals, especially when anaerobic microflora predominate

Pastes based on a mixture of long-acting antiseptics

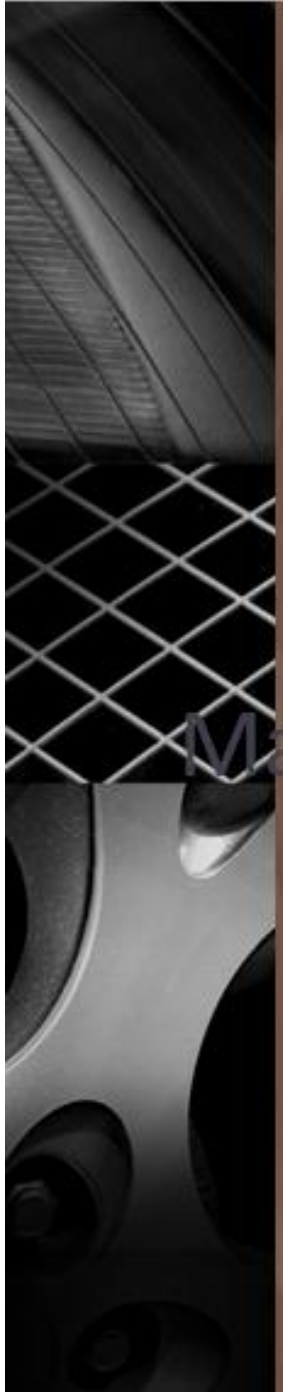
Tempofor

Composition:

- Menthol
- Timol
- Creosote
- Iodoform
- Camphor
- Filler

Disinfects and deodorizes the canal, does not cause dysbacteriosis

Use as a "permanent filling material" to fill root canals in deciduous teeth



Materials for temporary filling of tooth canals

Текст слайда

Pastes based on calcium hydroxide

Endocal

Composition:

- Calcium hydroxide
- Filler

It has antibacterial and lysing effect in relation to necrotic tissues. Calcium ions are involved in the reaction of bone formation, which stimulates reparative processes in the bone. It has a hemostatic effect. Due to the tissue fluid increases in the channel, clogging macro- and micro-channels, providing their temporary isolation

Pastes based on calcium hydroxide

Calasept

Composition:

- Calcium hydroxide
- Barium sulfate
- Sterile isotonic saline solution

Indications:

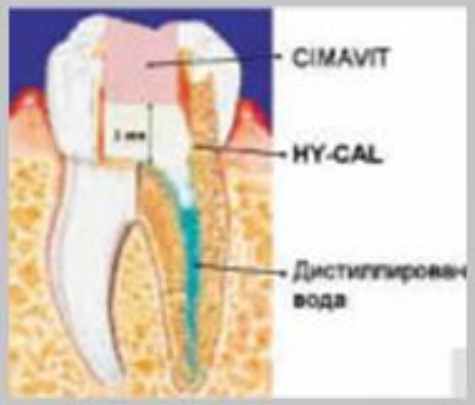
1. Temporary filling of the root canals with the usual technique of treatment. 2.
2 Treatment of perforations and fissures. 3.
Isolation of deep cavities and protection of the pulp.
- Calasept stimulates the formation of dentin bridges.
- Calasept has a strong bactericidal effect.
- Calasept stimulates the formation of hard tissue roots.

Pastes based on calcium hydroxide

HY-CAL (Pierre Rolland)

65% aqueous suspension of Ca(OH)2, packaged in disposable applicators of 110 mg of the drug

has a strongly alkaline reaction (pH 12.5-13) and a high buffer capacity



HY-CAL application technology

1. Instrumental treatment of root canals
2. Flushing the canals with sodium hypochlorite solution and then with distilled water
3. Excess moisture is removed from the tooth cavity and canal mouths
4. Channels are not dried out, but remain filled with water
5. Calcium hydroxide is applied to the bottom of the cavity and canal mouths in a layer of at least 1 mm thickness and sealed with an airtight dressing

Pastes based on a combination of calcium hydroxide and iodoform

Composition:

- silicone oil - due to its hydrophobicity provides adequate insulation of the root canal;
- Iodoform - has a powerful antibacterial effect;
- calcium hydroxide - provides osteoinductivity and very high radiopacity;
- fillers

Plastic hardening filling materials

Текст слайда

Endohermetics (silers)

1. Zinc-phosphate cements
2. Preparations based on zinc oxide and eugenol
3. Materials based on epoxy resins
4. Polymers containing calcium hydroxide
5. SIC
6. Preparations based on resorcin-formalin paste
7. Materials based on calcium phosphate (recognized by the ADA as the most promising, under development)

Zinc-oxide-eugenol-based pastes

Can be used alone or in combination with GPP

Positive properties:

- easy to insert into the canal
- optimal curing time (12-24h)
- good adhesion to the walls of the canal
- do not shrink
- quickly resorbed (eugenol diffusion into the bloodstream) when taken beyond the root apex
- antiseptic, anti-inflammatory action (after hardening - inert)

Zinc-oxide-eugenol-based pastes

- Cincoxide-eugenol paste
- Eodent
- Endometasone
- Esteason
- Tublisil

Zinc-oxide-eugenol-based pastes

Negative properties:

- Possibility of toxic and allergic effects on tissues
- Probability of resorption
- Probability of staining the crown of the tooth
- Probability of polymerization failure of the composite

Pastes based on polymer resins

Only used in combination with primary curing materials GPP, Thermafil

Positive properties:

- Easy to insert into the canal
- Long (8-36h) curing
- Stability in the channel
- Heat resistance
- X-ray contrast

Pastes based on polymer resins

The advantage of polymer systems is that by changing the chemical composition of these materials it is easy to achieve short curing times and at the same time maintain a sufficiently long working time.

- Intradont
- AH-26
- NA-plus
- Topsil

Polymers containing calcium hydroxide and/or hydroxyapatite

Only used in combination with primary curing materials GPP, Thermafil

- Biocalex
- Silapex
- Apexite
- Vitapex

Glass ionomer cements

Positive properties:

- low curing shrinkage
- chemical bonding to dentin

Negative properties:

- unsatisfactory working hours
- Difficulties with withdrawal from the canal

Glass ionomer cements

- Setas-Endo
- Endion
- Stiodent

They are not widely used

Resorcinol-formalin-based pastes

Positive properties:

- Strong antiseptic action
- Decontamination of dentinal tubules, pulp in unperforated canals
- X-ray contrast
- Bioinertness after curing

Negative properties:

- Component toxicity
- Irritating effect on periodontal tissues
- Tooth crown staining

Resorcinol-formalin-based pastes

- Resoden
- Forfenan
- Foredent
- Neotriozinc

Forfenan

Resorcinol-formalin-based pastes

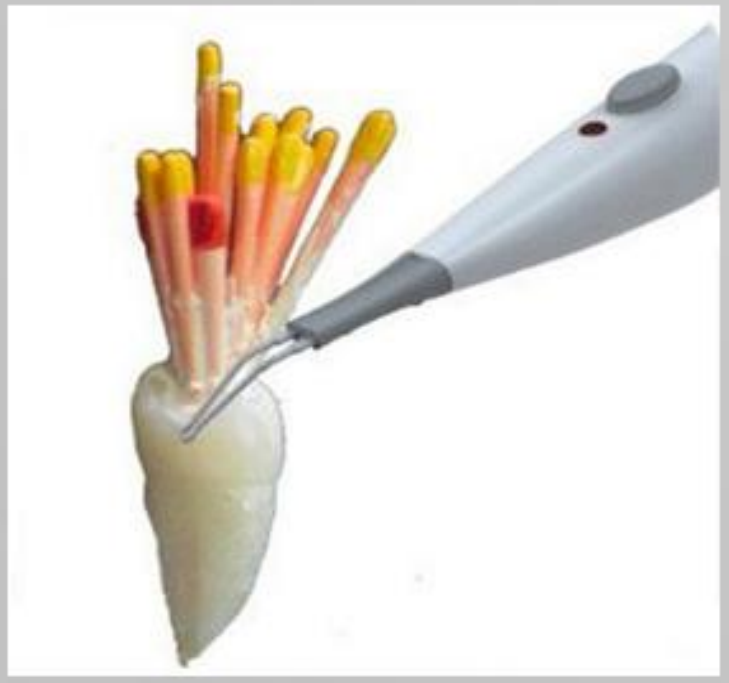
During polymerization, the paste heats up and releases a certain amount of formaldehyde gas, which penetrates the dentinal tubules, turning the albumin there into insoluble and aseptic mixtures.

ABSORBENT PAPER POINTS

- Absorbent paper points are made of rolled paper. They are used for removing moisture from prepared canals and are stiff enough to be inserted into the canal and then removed without losing their shape. Paper points are sterile, can be of different sizes correspond to the ISO and taper, also can have millimeters marks

ISO sizes #15-40
absorbent paper points

- Paper points with and without millimeter marks



Текст слайда

Solid sealing materials

Hardening fillings

Unplastic:

- metal (silver, titanium)
- plastic,
- fiberglass,
- The Thermafil system (a metal rod with a
- with gutta-percha).

Plastic:

- gutta-percha,
- plastic,
- fiber.

gutta-percha

Gutta-percha

- Gutta-percha (GP) is a substance from sap of gutta-percha trees (trees of the genus Palaquium particularly from Palaquium gutta). Gutta-percha was first used in dentistry in the late 1800s as a temporary restorative material and then to obturate root canal systems. Its use as a temporary filling material continued until 1950. The natural chemical form of gutta-percha is 1,4-polyisoprene, gutta-percha is an isomer of natural rubber.

- Obturation of root canal space has been performed for many years using a core of gutta-percha cones combined with various formulations of sealer cements. The gutta-percha cones can be inserted into the root canal with either cold lateral condensation, or through a method which involves softening with heat, which was introduced more than 40 years ago by Dr. Schilder. The gutta-percha and sealer filling material has been the most popular and most tested filling material throughout the history of endodontics. Used without sealer, gutta-percha does not provide a seal.

Rubber

Rubber is polymers of isoprene (2-methyl-1,3-butadiene)

Isoprene has spatial isomers and can have different structures despite the same composition

Natural rubber is amorphous, soft and highly elastic

Composition of gutta-percha pins

The main form of gutta-percha use are gutta-percha pins or obturators, which are softened, compacted by hot vertical and lateral condensation. The composition of gutta-percha pins produced by different manufacturers is not the same

Composition of gutta-percha pins

Component	Quantity, %	Purpose
Gutta-percha	19-22	Resin
Zinc oxide	59-75	Filler
Heavy metal salts	1-17	For radiopacity
Wax, resins	1-4	Plasticizer

- The variations in content come from attempts of manufacturers to improve or modify some properties; but on the whole properties are the same regardless of the manufacturer or brand.

- ***General properties of gutta-percha*** as a dental material for root canal obturation are as follows.

- ► High biocompatibility: it does not react with body fluids; is inert irrespective of alkaline or acidic medium; non allergenic.
- ► Dimensional stability. When cold gutta-percha is very stable and shows no shrinkage. But any manipulating with gutta-percha using heat or a solvent will result in some shrinkage (1-2%) of the material. Shrinkage of the core material is not desirable when attempting to seal a canal. Compaction with spreaders, condensers or carriers is usually the means used to compensate for this shrinkage of the core material.
- ► Ease of handling: easy to manipulate. Gutta-percha could be removed from root canal if necessary.
- ► Adaptation to apical foramen: apical seal is a prime importance in obturation, gutta-percha provides better apical sealing compared with other materials.
- ► Gutta-percha is soluble in chloroform, eucalyptol and less well in turpentine. This property of gutta-percha allows it to be removed for post preparation and in the retreatment of non-healing cases.

- Chemically pure gutta-percha exists in two distinctly different crystalline forms (phases) α-phase and β-phase, and both phases are used in dentistry. Natural gutta-percha has α-phase. Gutta-percha undergoes phase transitions when heated from beta to alpha phase. In the manufacturing process natural gutta-percha is warmed, and if cooling is done fast, natural α-phase converts to β-phase; if cooling is done slowly, gutta-percha continues to be α-phase. Comparison of α-phase and β-phase gutta-percha are presented in table

α-Phase	β-Phase
Brittle at room temperature	Stable and flexible at room temperature
Low viscosity (highly flowable) when heated	High viscosity (less flowable) when heated
Examples of use In dentistry	
Thermaplasticized gutta-percha (Thermafill, cartridges for obturation gun)	Gutta-percha cones

Properties of α-phase and β-phase gutta-percha

In dentistry gutta-percha is used in the following variants.

► Cold.

• Cones.

► Thermaplasticized.

• Pre-heated (in heating device):

- softened flowable mass from obturation gun;

- carrier-based gutta-percha (e.g. Thermafill).

• Thermomechanicaly plasticized (frictionally warmed on rotary carrier):

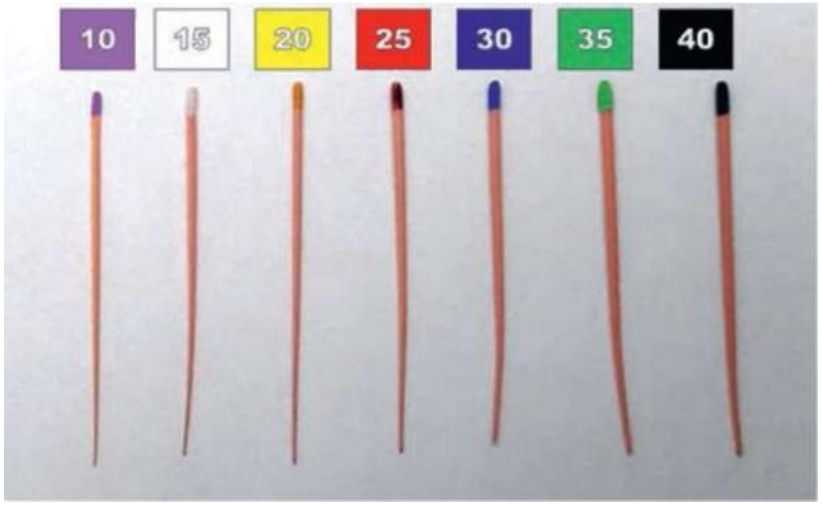
- carrier-based gutta-percha (e.g. QuickFill).

Dental Gutta-Percha Cones

- Dental gutta-percha cones could be standardized and non-standardized according to their size.

- In standardized GP cones the diameter of apical tip corresponds to ISO size, and the top of gutta-percha cone corresponds to ISO size color mark, available in different tapers. Taper is gradual increasing of guttapercha cone diameter (file, paper points etc.) from apical tip toward the top. In endodontics the taper is marked in percents or hundredths of millimeter

- (written variants to mark taper: 02, 0.02 or 2%). So, GP cone size #20 and taper 02 (marked 20/02) at the tip has diameter 0.20 mm; 1 mm from the tip D=0.20+0.02=0.22 mm; 2 mm from the tip D=0.22+0.02=0.24 mm, etc.

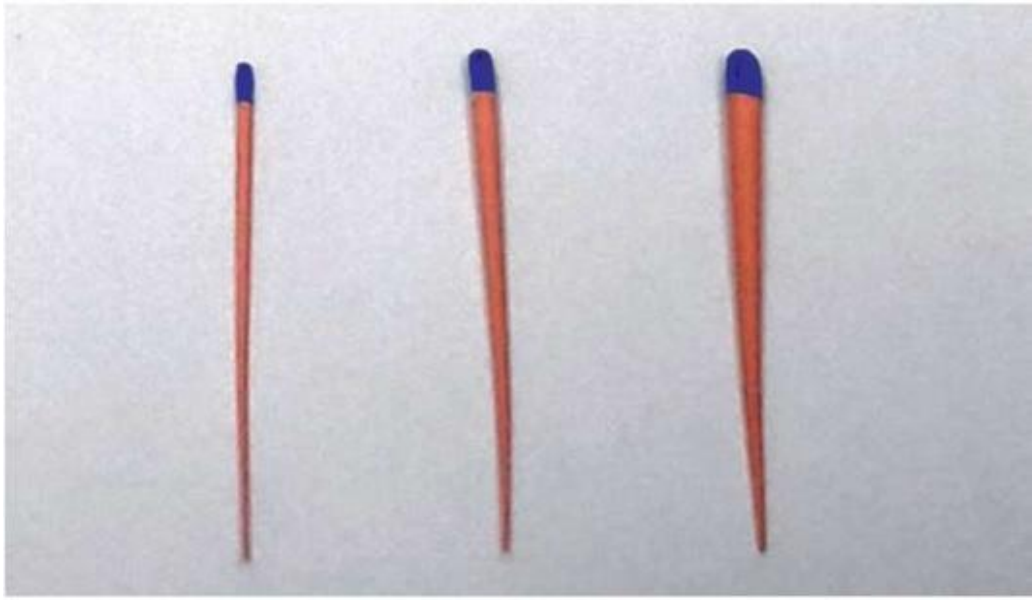


Standardized GP cones with ISO color mark at the top

- The taper of standardized GP cones can be of the following types.

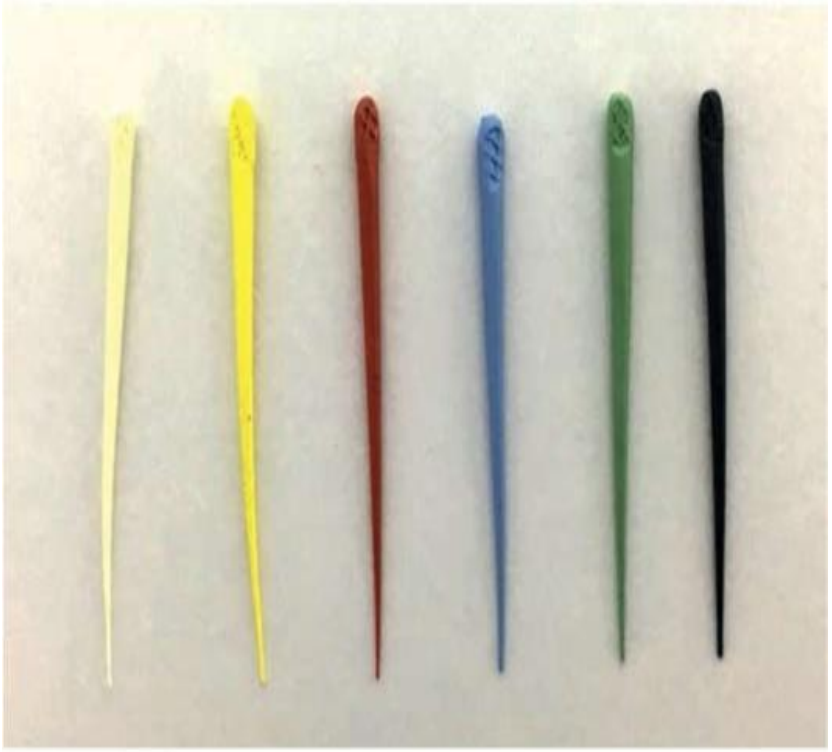
- ► Conventional taper is taper 02.

- ► Greater taper means all gutta-percha cones with a taper greater than conventional - 04, 07, 06, 08, etc. In this group it is necessary to mention gutta-percha cones corresponding (both in size and taper) to specific file system such as ProTaper Gutta-Percha, Reciproc Gutta-Percha, etc.

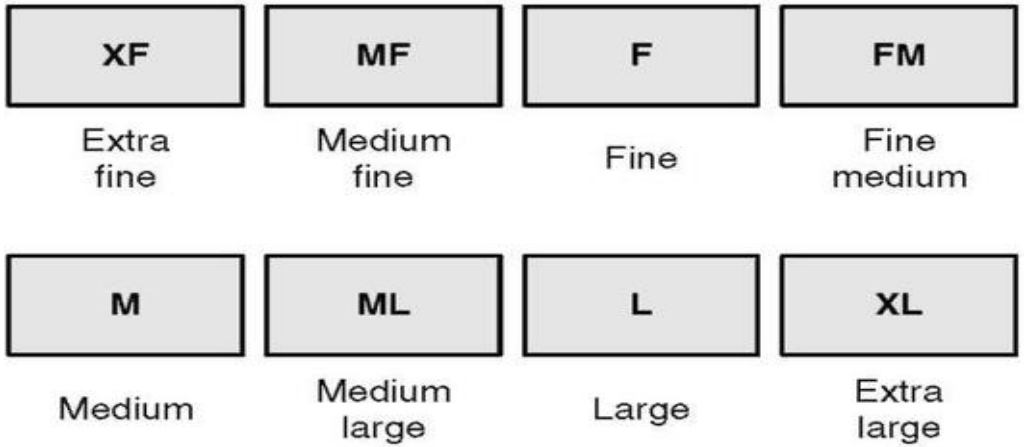


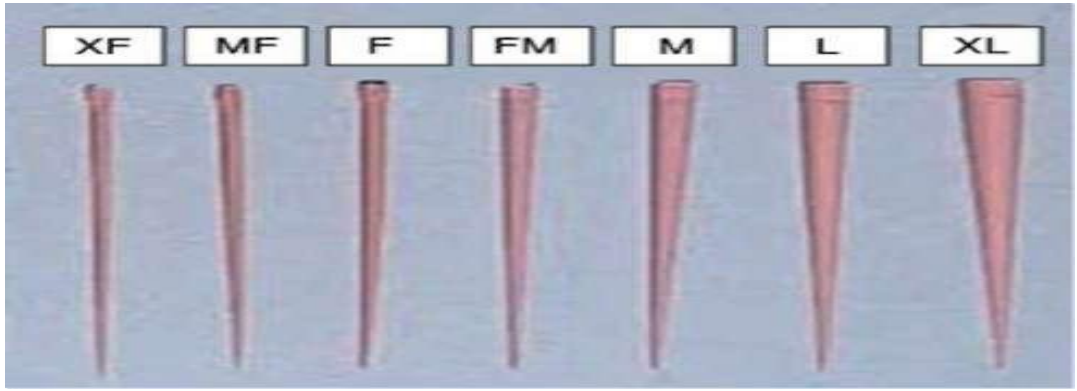
From left to right: conventional taper GP cone 30/02, greater taper GP cones 30/04, 30/06

- Standardized GP cones can be of natural pinky-orange color where ISO color marks are just at the top; or the entire cone can be colored according to ISO color codin



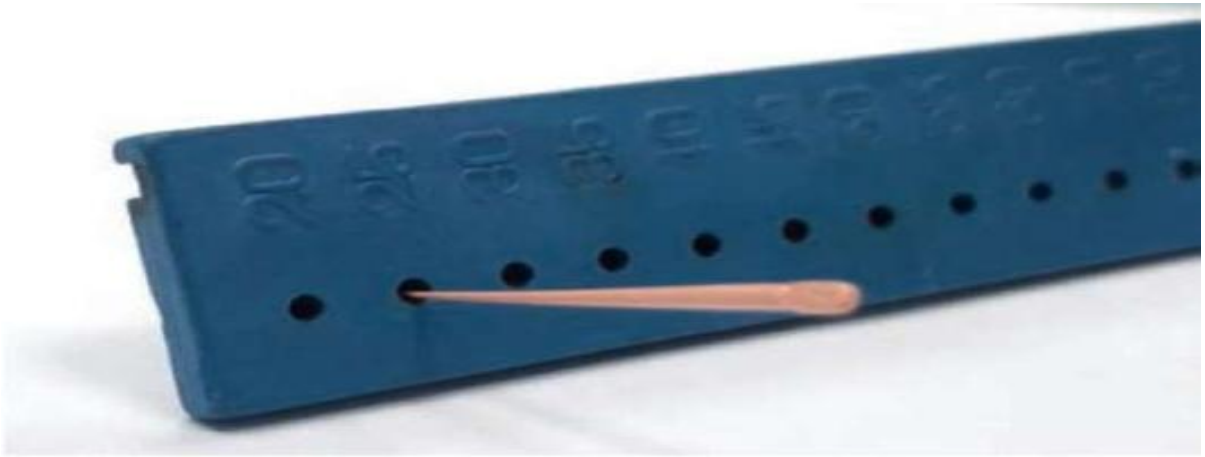
- In non-standardized (conventional) GP cones the apical tip diameter does not comply with ISO. They are of natural pinky-orange color with no ISO color marks. Cones can be of different size: large, medium, fine, etc.





- Thin cones can be used as additional cones in lateral condensation technique. When using non-standardized cone as a master cone you need to calibrate its tip according to ISO size with special endodontic gauged ruler (because all modern endodontic instruments have ISO sizes; so after canal instrumentation the apical foramen has an ISO diameter, and the master-cone should it and seal it well). In this ruler each hole corresponds to one of ISO size. For instance, if inserting a cone in hole #25 and cutting a part of cone through the hole, the apical size of gutta-percha cone will be 25 ISO.

- Both standardized and non-standardized GP cones can have millimeter marks. Millimeter marks indicate GP cone length from the tip to the mark. It is helpful for a fast and accurate depth measurement and GP cone insertion.



Calibration of non-standardized GP cone with endodontic gauged ruler: cone is inserted in hole #25 from one side. From the other side the cone part coming through a hole should be cut, diameter of the cone will be #25 ISO

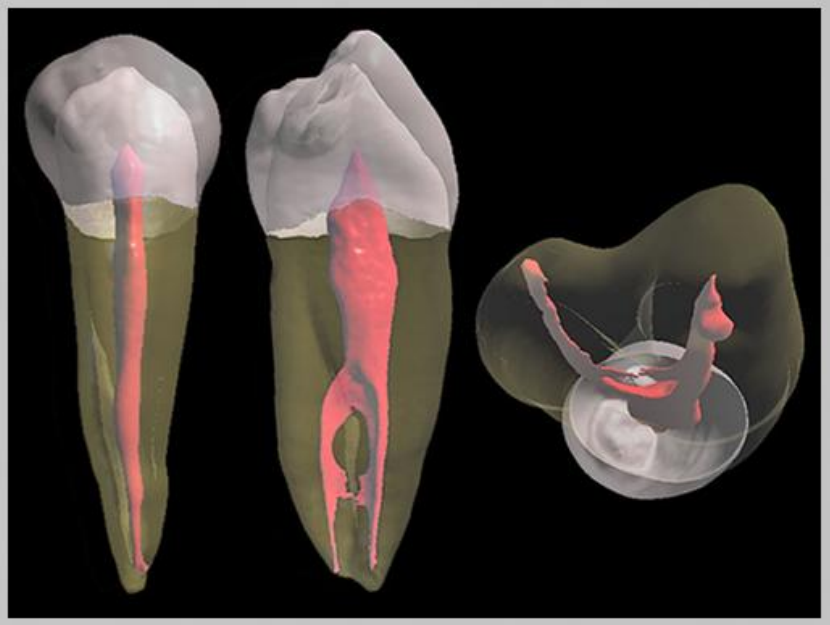
- Marks can be different, e.g. four marks per cone (19, 21, 23, 25 mm); six marks percone (16, 18, 19, 20, 22, 24 mm)

Standardized GP cone with six millimeter marks. a - GP cones #40/02 (left - with no marks, right - with millimeter marks); b - schematic drawing of a GP cone with six marks

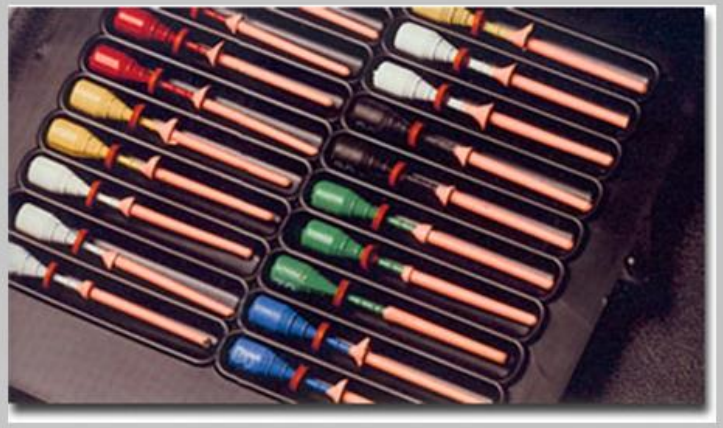
- GP cones are available in small plastic boxes, slider-boxes or round organizers

From left to right: slider-box, round GP organizer (image courtesy of DiaDent Group International), small plastic boxes of gutta-percha #20 and #25

Thermafil System



Gutta-percha a-phase has better thermoplastic characteristics, and therefore it is preferred to be sealed in the root canal in a softened hot state. This technique was first developed in 1978.



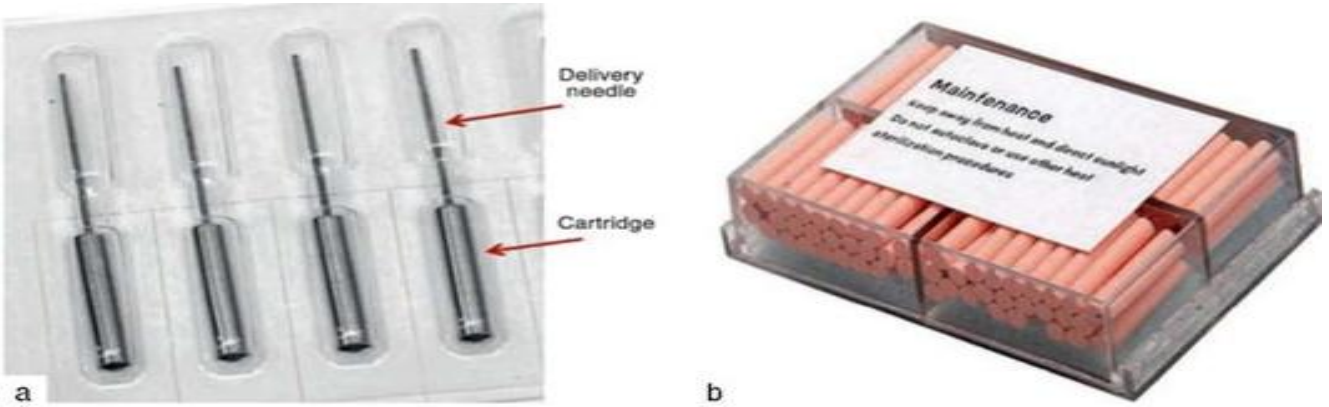
Thermafil System

It was subsequently upgraded by using plastic core carriers (Thermofil) and injection guns (Obtura) to inject softened gutta-percha. However, with a wide apical opening, there is a risk of material escaping beyond the apex of the root

Furcation canal of the upper sixth tooth

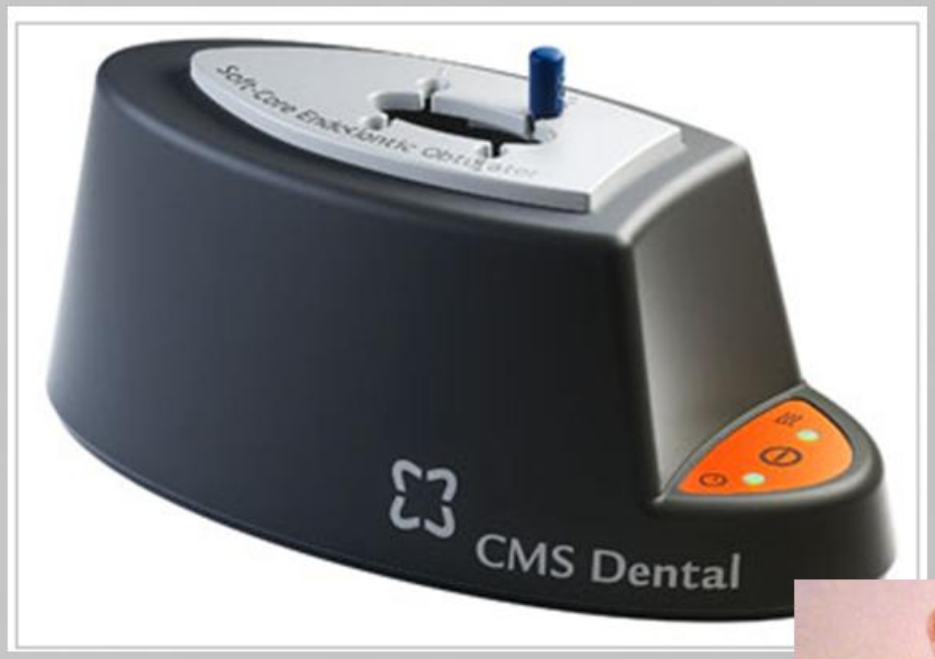
Thermaplastisized Gutta-Percha

- Thermaplasticized GP is alpha-phase GP used for warm techniques. It is available in cartridges and bars (also called pellets) for obturation gun (e.g. for such devices as BeeFill and Obtura III) for vertical compaction techniques; or in a plastic or metal carrier (such as Thermafil or Quick-Fill)



a - cartridge with applicator needle (also called delivery needle). Cartridges for BeeFill obturation gun contain a bar of alpha-phase gutta-percha inside. Cartridge is for singleuse and cannot be recharged;
b - alpha-phase gutta-percha bars (or pellets) for Obtura III obturation gun. Due to the gun design gutta-percha bars are placed directly in the gun and can be added if necessary

Thermaplastized gutta-percha in carriers. Thermafil obturator; gutta-percha softens in special oven (picture courtesy of DENTSPLY IH Ltd.)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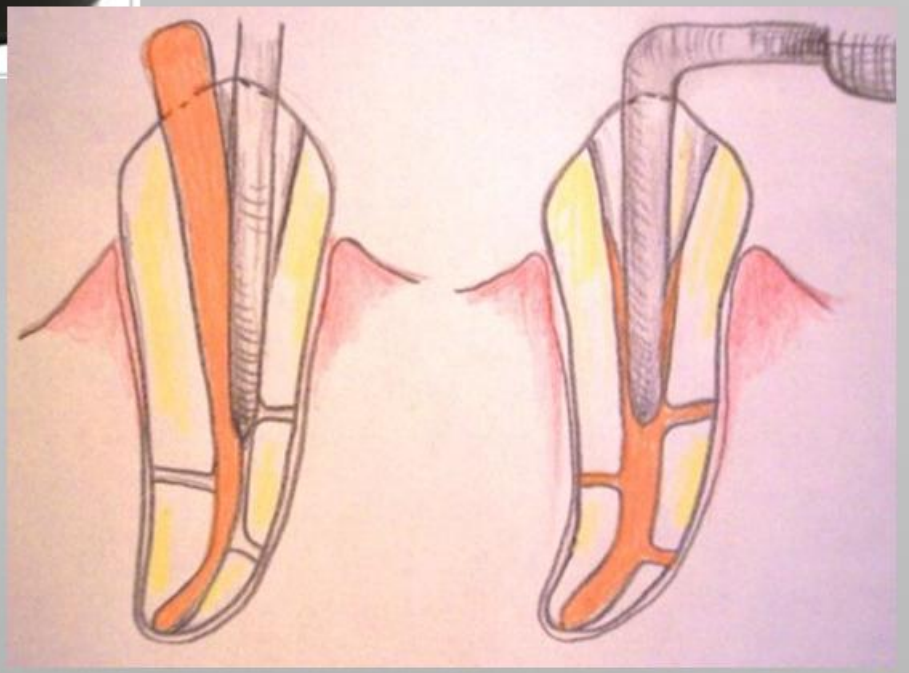
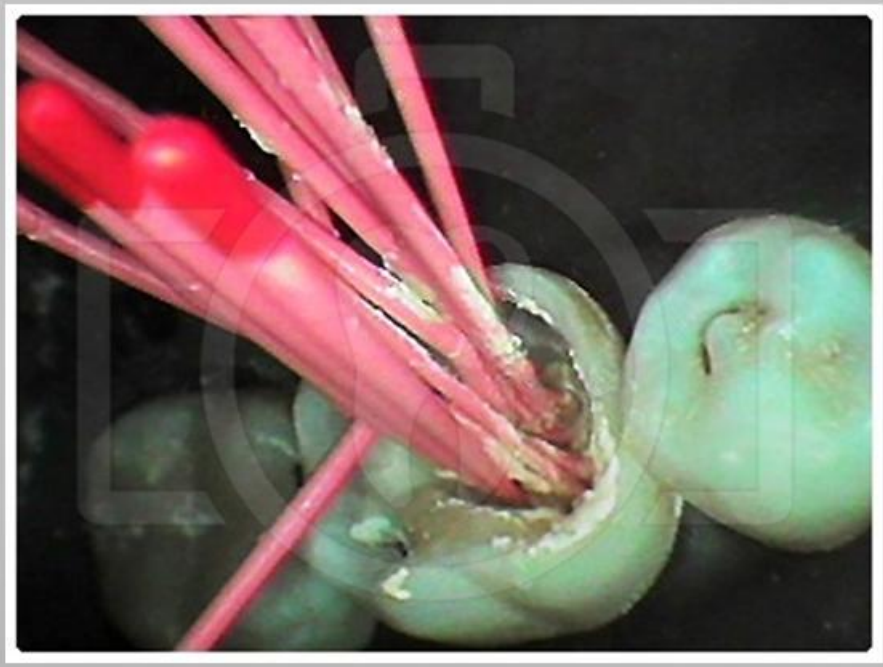
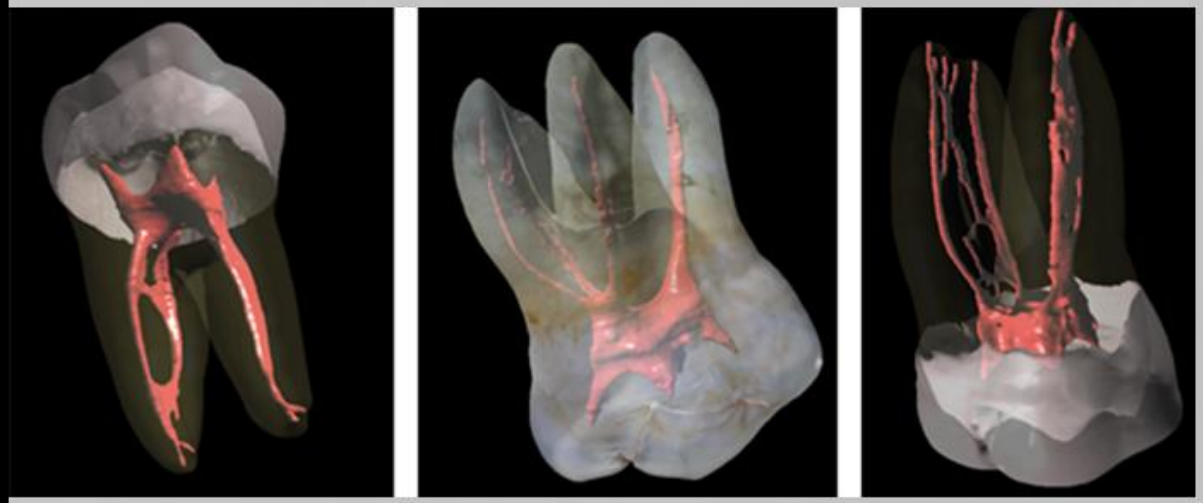


Benefits of gutta-percha

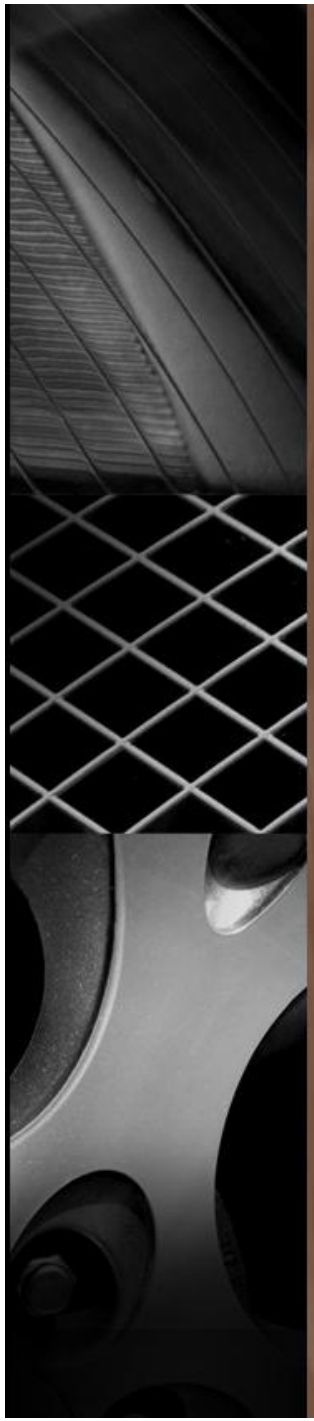
- bioinertness
- mild antibacterial effect
- easy to insert into the canal
- has no shrinkage
- Waterproof
- X-ray contrast
- does not stain tooth tissue
- easy to dispose of if necessary





Disadvantages of gutta-percha

- sterilization complexity
- inability to achieve absolute compaction in the channel
- the need for additional application of sealing compositions



Sealants for root canal fillin

Properties of root canal sealants

- ease of use;
- absence of air bubbles and homogeneity when mixing;
- spreading to the thickness of a thin film;
- be insoluble;
- to fit well against the wall of the canal;
- provide radiopacity;
- to be biocompatible;
- be bactericidal or at least bacteriostatic;
- can be easily removed from the canal if necessary

Sillers based on zinc oxide and eugenol

Mechanism of action:

1. When in contact with zinc-oxide-eugenol paste, the post adsorbs eugenol and softens slightly
2. Eugenol reacts with the zinc oxide in the post
3. A hydrophobic homogeneous mass is formed in the canal, which ensures reliable ablation

Sillers based on zinc oxide and eugenol

Tublesil Express

The most common sealant is zinc-oxide-eugenol cement (e.g., Tubliseal, Kerr)

Glass ionomer and calcium hydroxide cements are also used

Sillers based on zinc oxide and eugenol

Tubblesil

Zinc-oxide-eugenol-based cements tend to cause some inflammatory tissue reaction, probably related to the presence of free eugenol

Cement should not be taken beyond the root apex into the periapical tissues

Sillers based on polymer resins

Negative properties:

- Polymerization shrinkage over 2%
- In case of insufficient drying of the root canal - marginal adhesion failure
- High cost

Sillers based on polymer resins

AH-26

Polymeric systems are highly biocompatible because none of them contain eugenol

A moderate cytotoxic reaction to freshly prepared AH26 may be related to the release of formaldehyde, which is formed as a byproduct of the polymerization process

Sillers based on polymer resins

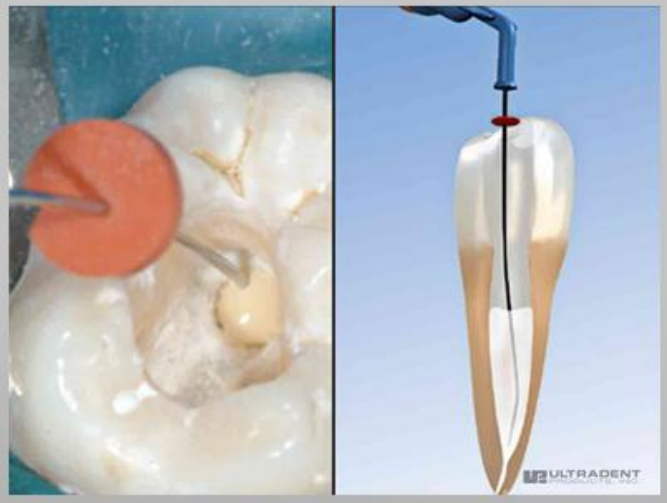
Because AH26 takes some time to polymerize, patients may develop some degree of sensitivity that may be associated with its use. NA Plus has been shown to release only a small amount of formaldehyde (3.9 mg/kg) compared to NA26 (1347 mg/kg).

AN-PLUS

Sillers based on polymer resins

EndoREZ (Ultradent) has hydrophobic properties, increased fluidity, chemical affini with dentin, seals even wet canals

Dual curing mechanism: chemical and light



Polymeric materials containing hydroxide

Acrosil

Composition:

Basic paste : glyciretic acid (enoxolone), metenamine, radiopaque filler.

Catalyst : calcium hydroxide, DGEBA, radiopaque filler

Does not contain eugenol (can be filled with composites)

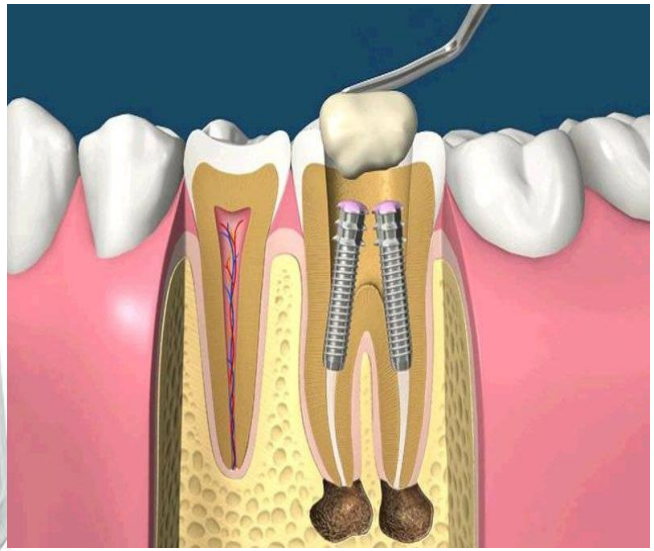
Root pins

Passively lockable pin constructions

- metal core inlays
- ceramic root posts
- standard smooth metal root canal pins:
  - VLOCK system (Komet)
  - MOOSER system (Maillefer)
- fiberglass root posts
- carbon root pins;

- **Silver points**

- Silver points (also called silver cones) in combination with cement (zinc-phosphate or zinc-eugenol) were historically indicated for obturation of root canals and were more or less successfully used in absence of any effective alternatives. However, modern techniques and improved materials provide clinicians with much better options.
- American Association of Endodonics (AAE) does recommend against the continued use of silver points, because of the following disadvantages.



- ► Spontaneous corrosion: corrosion byproducts can cause irreversible staining of the tooth structure and surrounding tissues.

- ► Silver points have no plasticity and fail to conform to the shape of the root canal system.

- ► Post and core buildups become impossible with intact silver points in root canal.

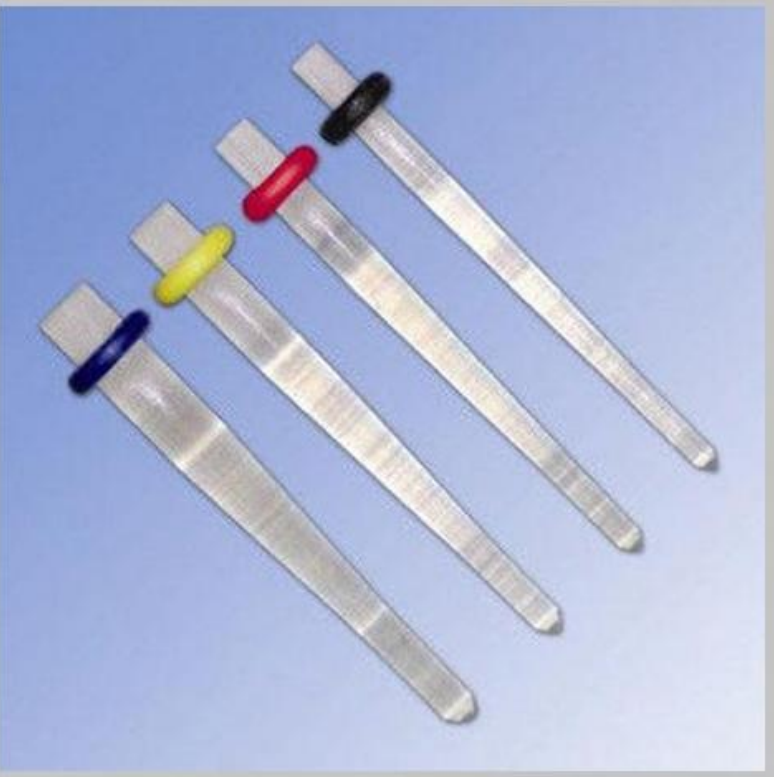
- ► Apical surgery becomes more complicated due to the difficulties encountered when attempting a root-end preparation in canals that are filled with metal.

- Despite these facts, the AAE does not recommend the prophylactic revision (endodontic retreatment) of silver point obturation, unless there is clear evidence of endodontic pathosis or if the silver points complicate proper restoration of the tooth.

- Despite all disadvantages of silver points it is still available in worldwide dental market and used by some clinicians.

Fiberglass pins

The optimal combination of fiberglass and matrix, which would be similar in its physical properties to the tooth structure and still have the strength of metal, is 75% fiberglass, 25% composite (can be up to 42%). The bending strength is 560 MPa. To break a fiberglass pin with a diameter of 1 mm, it is necessary to apply a force of 160 kg.



Placement of a fiberglass post

Properties of fiberglass pins

1. biocompatibility with tooth tissue
2. stressful, unclenching stress on the root wall
3. Creating a monolithic structure with dental hard tissues and composite cement
4. Possibility to restore a residual limb or perform a restoration in one visit
5. modulus of elasticity of the fiber is equal to the modulus of elasticity of dentin of the root
6. No corrosion or discoloration
7. the possibility of obtaining a highly aesthetic result of the restoration due to the proximity of the light conductivity indicators to similar indicators of the tooth tissue.