The Endodontics

Phases of root canal treatment

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Phases of root canal treatment

Instrumentation

- The shaping of the root canals is necessary with the removal of the debris and elimination of bacteria. The original shape of the canal and the apical constriction should be kept. Therefore, the final shape of the root canal should be tapered from the crown to the apex.

Irrigation

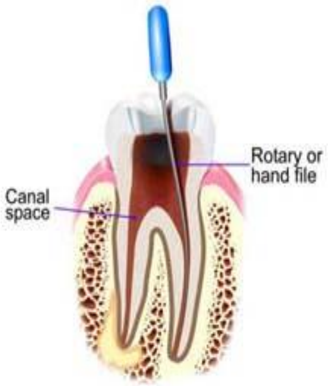
- This preparation should be undertaken with copious amounts of irrigation.
- After, that, a temporary restoration is placed to conserve the remaining tooth structure.

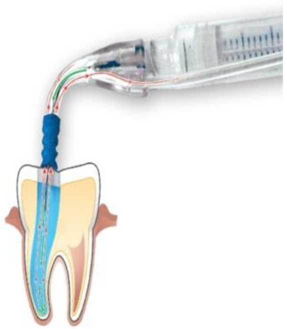
Obturation

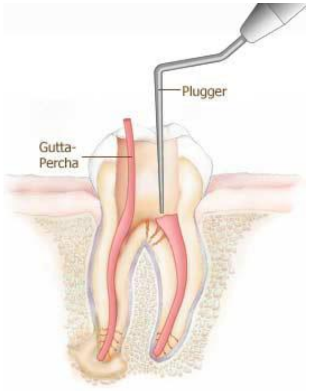
- Obturation of root canal (root canal filling) should be done after the completion of root canal preparation and elimination of infection and the canal can be dried. It consists of a semi-solid material in combination with a root canal sealer. The root canal sealer fills the voids between the semi-solid material and root canal wall.

Phases of root canal treatment

1 Instrumentation → 2 Irrigation → 3 Obturation







Phase1: Instrumentation

In general, endodontic cavity preparation is divided into two parts, coronal cavity preparation and radicular cavity preparation. It includes different principles. G. V. Black's principles for restoration of essential teeth are also applied during the preparation of the endodontic cavity.

1. Coronal cavity preparation comprises,
    - Outline form
    - Convenience form
    - Removal of the remaining carious dentin and defective restoration.
    - Toileting of the cavity
2. Radicular cavity preparation includes,
    - Outline form
    - Convenience form
    - Toilet of the cavity
    - Retention form
    - Resistance form
    - Extension for prevention.

Phase1: Instrumentation

1. Coronal cavity preparation

- Outline form is undertaken by keeping the original internal anatomy of the pulp which coincides with the external anatomy of the tooth. This is done by keeping instrumentation within the confines of the canal space. The size of the pulp space should be considered according to the age of the patient. In addition, the shape of the pulp space should be considered according to the type of the tooth. For example, the shape of the pulp chamber of molars is usually triangular, while it is elongated oval in shape in maxillary premolars . Finally, the number of the root canal, their position and their curvature should be considered as well. In the internal anatomy, three factors should be considered: (a) the size of the pulp chamber, (b) the shape of the pulp chamber, and (3) the number, curvature and position of individual root canals.

Phase1: Instrumentation

1. Coronal cavity preparation

- The convenience form is done by preparing or modifying of the cavity outline form to get convenient access into the pulp chamber, in order to allow accurate instrumentation and irrigation and to accommodate the filling technique. The importance of the convenience form is : (a) unobstructed access to the canal orifice, (b) direct access to the apical foramen, (c) cavity expansion to accommodate filling techniques, and (d) complete authority over the enlarging instrument.

Phase1: Instrumentation

1. Coronal cavity preparation

- The removal of the remaining carious tooth or defective restoration to: (a) reduce as much bacteria as is possible, in order to (b) reduce the possibility of crown discolouration (c) and prevent bacterial percolation from saliva into the prepared area.

Phase1: Instrumentation

1. Coronal cavity preparation

- Toileting of the cavity is then carried out by removal of all caries, debris and necrotic material from the pulp chamber before starting the radicular preparation. This is important as these things may obscure the root canal or stain the crown. This can be completed by irrigation of the cavity with an irrigating agent.

Phase1: Instrumentation

2. Radicular cavity preparation

2. For radicular cavity preparation, the same principles discussed; the outline forms, convenience form , and the toileting of the cavity.

- The retention form is considered in order to make a firm fit of the gutta-percha filling material in the apical 2-3 mm of the canal space. This results in the filling material being sealed against the leakage or percolation of fluids.
- The resistance form is completed by developing apical barrier, “apical stop” at the normal apical constriction, with the purpose of compacting the root filling material.
- Finally, extension for the prevention is done for the radicular cavity to reduce the possibility of future problem. This needs enough peripheral enlargements of the canal, to remove all debris and then to fully seal the root canal.

Phase1: Instrumentation

2. Radicular cavity preparation

1. Techniques of mechanical preparation
2. Instruments or methods of mechanical preparation
3. Types of movement of instrument (file or reamer)

- Root canal debridement is necessary, in order to create space so that an antimicrobial irrigating solution can be used.
- In the past, it was recommended that root canals should be expanded, in particular the apical 5 mm to at least #30 or even to #40 in order to flush them properly. However, recent research concluded that root canals should be enlarged to a larger size than had been initially recommended, especially for infected canals.

Phase1: Instrumentation

2. Radicular cavity preparation

1. Techniques of mechanical preparation

- Generally, there are 2 techniques. One technique prepares the apex of the root canal and progresses coronally toward the root canal orifice (apical-coronal), and the other one prepares the coronal part of the root canal and progresses apically toward the apex the crown-down (coronal-apical or step-down) techniques. A hybrid technique can be also used by combination of more than one technique, such as quite clumsily “step-down-step-back technique or modified double-flared technique”.
- The apical coronal-technique can be divided into:
  1- standardized
  2- step-back (telescopic or serial)
  3- modified step-back
  4- balanced force (with the Flex-R-File “modified K-type file”)
- The coronal-apical technique can be divided into:
  1- step-down (or crown-down)
  2- modified step-down

Phase1: Instrumentation

2. Radicular cavity preparation

1. Techniques of mechanical preparation

- Two traditional techniques are used for preparation of the radicular part of the canal space. These are the step-back (apical-coronal) and the crown-down (coronal-apical or step-down) techniques.
- In the step-back technique, the preparation begins at the apical part of the canal, whilst the other technique starts the preparation at the coronal part of the canal. They then both continue coronally and apically respectively.
- The purpose of these techniques is to ensure thorough cleaning and debriding of the canal space and proper shaping of the canal for obturation.

Phase1: Instrumentation

2. Radicular cavity preparation

2. Instruments or methods of mechanical preparation

- Instruments or methods of mechanical preparation are either manual or power-driven instruments.
- The manual instruments are:
  1- barbed broaches
  2- reamers
  3- K-file (K-File, K-flex file, Flexo-file, Flex-R-File)
  4- headstrom file
  5- nickle-titanium K-file
- The power driven instruments are:
  1- rotary (Gates-Glidden drills, Pesso reamers or drills and rotary nickel-titanium instruments)
  2-ultrasonic (Cavi-Endo and Piezoelectric)
  3- sonic
  4- laser

Phase1: Instrumentation

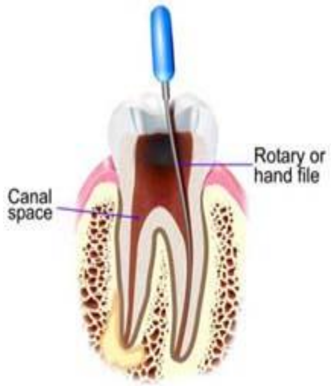
2. Radicular cavity preparation

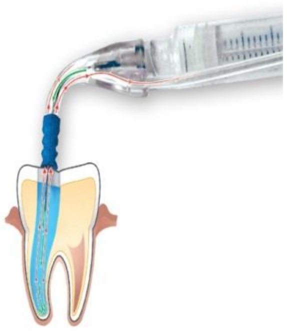
3. Types of movement of the file or reamer

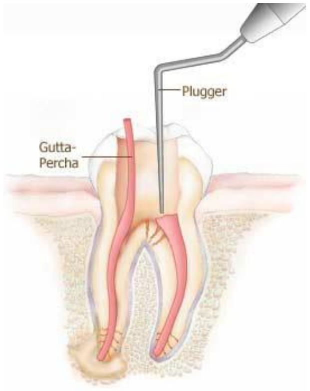
1- filing motion (push-pull)
2- reaming motion
3- combined reaming and filing motion
4- watch-winding motion (stem winding or twiddling)
5- watch-winding and pull motion

Phases of root canal treatment

1 Instrumentation → 2 Irrigation → 3 Obturation







Phase2: Irrigation

- Root canal systems cannot be adequately cleaned and disinfected by mechanical methods alone. Within the current body of knowledge, it has become apparent that a key role of mechanical instrumentation is to develop a pathway for the effective exchange of irrigant solutions throughout the length of the canal system.
- An ideal irrigating solution should not only flush debris from canal systems, but should be actively antimicrobial, and actively remove remnants of soft tissue from canal ramifications. The solution should combine these abilities and also have only a slight potential to cause damage to the host hard and soft tissues.
- At present, the most used irrigant solution is sodium hypochlorite (NaOCl), which is relatively inexpensive, has been shown to be both antimicrobial and to have tissue-solvent activity, other potential irrigants range from the commonly used (e.g. chlorhexidine, EDTA and citric acid) to the less common (e.g. sterile water and tolonium chloride).

Phase2: Irrigation

Standard irrigant agents

1. Sodium Hypochlorite (NaOCl)
2. Ethylenediamine Tetra-Acetic Acid (EDTA)
4. Citric Acid($C_6H_8O_7$)
5. Chlorhexidine

Alternative irrigant agents

1. Hydrogen peroxide (H_2O_2)
2. Sterile water and saline
3. Iodine (I_2)
4. Chloramine-T
5. Photo-activated disinfection (PAD)
6. Electro-chemically activation
7. Other methods (25% tannic acid solution, 40% polyacrylic acid, MTAD, 9-amino acridine, Ozone (O_3) and $Ca(OH)_2$)

Methods of irrigant delivery and agitation

1. The Syringe
2. Manual dynamic exchange
3. Passive ultrasonic activation
4. Endoactivator
5. EndoVac

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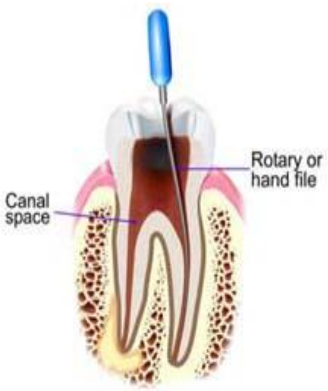

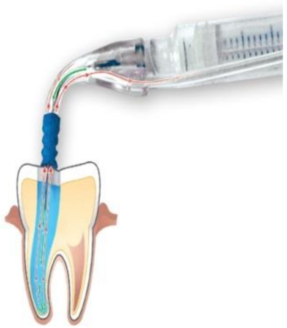

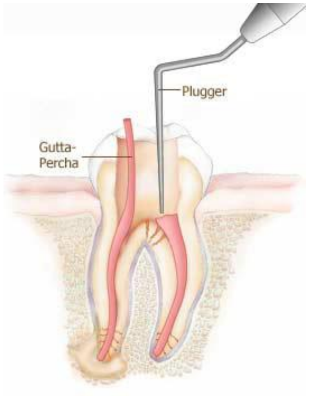

Phase3: Obturation

Objectives

- to fill the whole canal system (development of fluid tight seal), to block the apical foramina dentinal tubules and accessory canals.
- to prevent the passage of microorganisms
- to prevent the passage of fluid along the root canal

The prepared root canal should be filled completely unless space is needed for a post.

Phase3: Obturation

Figure 1. Root canal filling

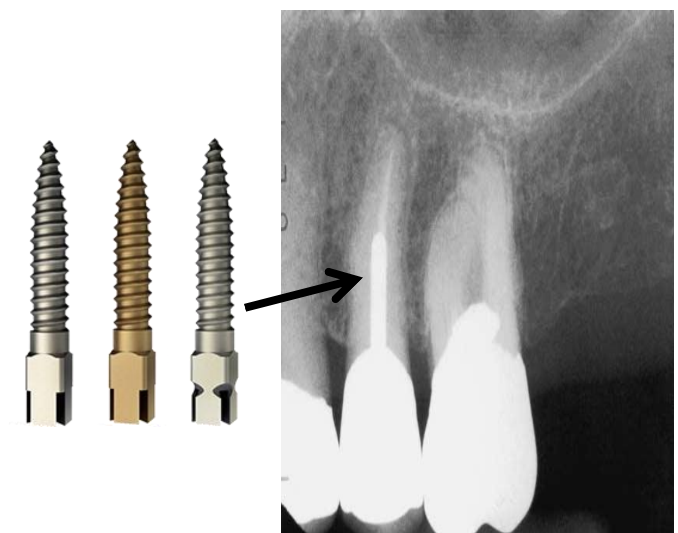

Figure 2. Five millimetres of gutta-percha were retained in the maxillary premolar and the post extended to that point.

Phase3: Obturation

- The root canal filling should consist of a (semi-) solid material in combination with a root canal sealer to fill the voids between the (semi-) solid material and root canal wall.

Figure 3. Gutta-percha (left) and silver point (right).

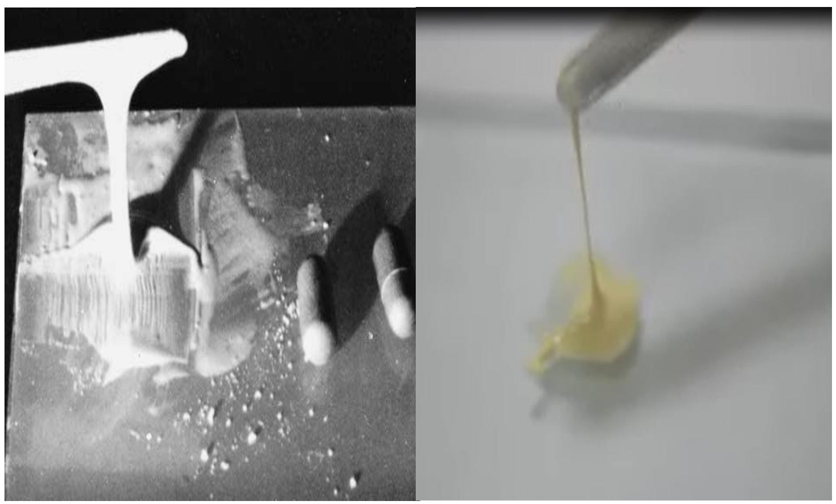

Figure 4. Root canal cement should be mixed to thick, creamy consistency, which may be strung off slab for 1 inch.

Phase3: Obturation

Grossman showed that ideal root canal filling materials (plastics, metals and cements) should be:

1. easily introduced into a root canal
2. biocompatible
3. dimensionally stable.
4. able to seal
5. should not stain tooth structure
6. unaffected by tissue fluids
7. insoluble
8. nonsupportive of bacterial growth
9. radiopaque
10. removable from the canal, if retreatment is needed

- Gutta-percha and silver points meet these requirements.
- Gutta-percha and silver points must be cemented inside the root canal.

Phase3: Obturation

Grossman showed that a good root canal sealer should:

1. be tacky when mixed to provide good adhesion between it and the canal wall when set.
2. make a hermetic seal.
3. be radiopaque so that it can be visualized in the radiograph.
4. The particles of powder should be very fine so that they can mix easily with the liquid.
5. not shrink upon setting.
6. not stain tooth structure.
7. be bacteriostatic or at least not encourage bacterial growth.
8. set slowly.
9. be insoluble in tissue fluids.
10. be tissue tolerant, that is, nonirritating to periradicular tissue.
11. be soluble in a common solvent if it is necessary to remove the root canal filling.

Phase3: Obturation

Methods of obturating the root canal space

II. Apical-third filling

A. Lightspeed Simplifill
B. Dentin-chip
C. Calcium hydroxide

I. Solid core gutta-percha with sealer

A. Chemically plasticized cold gutta-percha
B. Cold gutta-percha points
C. Canal-warmed gutta-percha
D. Thermoplasticized gutta-percha

III. Injection or spiraling filling

A. Cements
B. Pastes
C. Plastics
D. Calcium phosphate

Phase3: Obturation

I. Solid core gutta-percha with sealer

A. Chemically plasticized cold gutta-percha (Essential oils and solvents)

1. Eucalyptol
2. Chloroform
3. Halothane

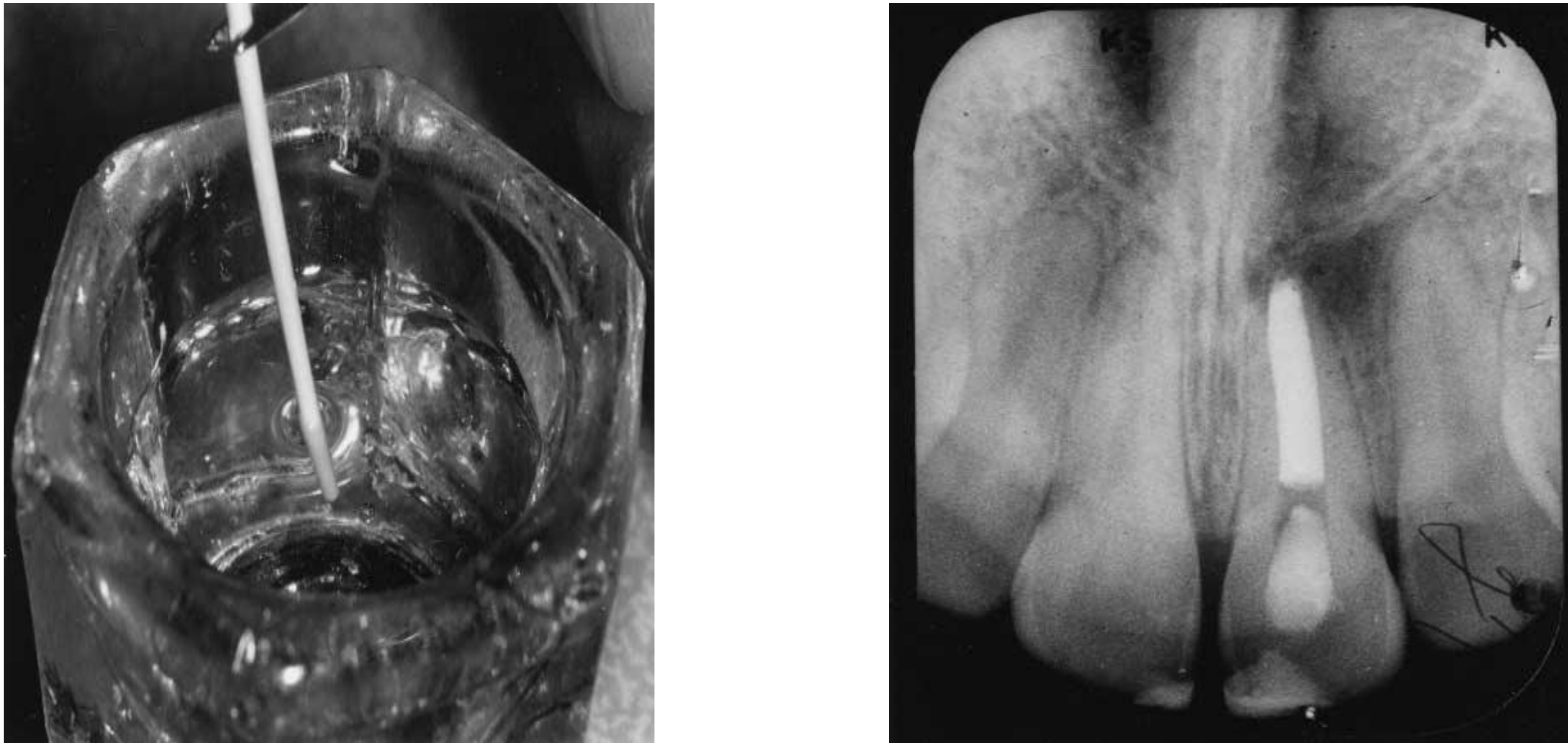

Figure 8. Chloroform dip technique.

A, Note that just the tip is immersed and for only 1 second. B, Final compaction of tubular canal. Warm gutta-percha/vertical compaction is preferred technique for cases with such thin walls.

Phase3: Obturation

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Phase3: Obturation

I. Solid core gutta-percha with sealer

B. Cold gutta-percha points

1. Lateral compaction

2. Variations of lateral compaction

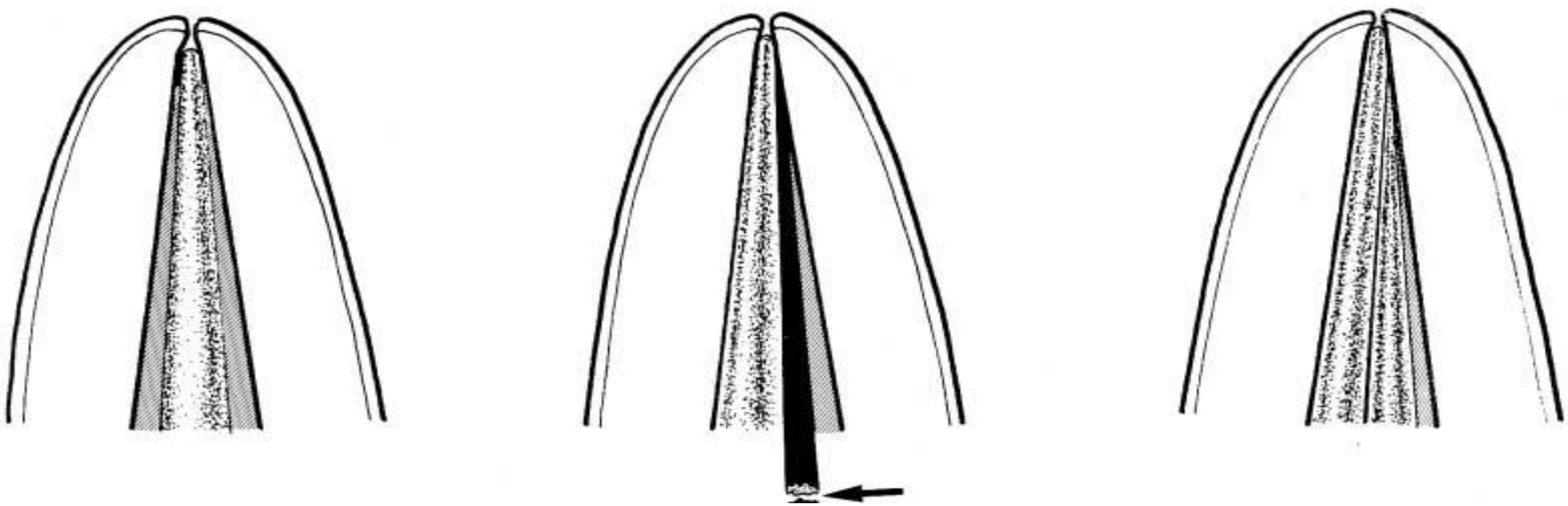


Figure 5. Lateral compaction, multiple-point filling procedure.

Spreader has previously been tested to reach to within 1.0 mm of apical constriction. Thin layer of sealer lines canal walls, tip of point is coated with cement.

A, Primary point is carried fully to place, to within 1.0 mm of “apical stop.’’ Excess in crown is severed at cervical with hot instrument.

B, Spreader (arrow) is inserted to full depth, allowed to remain 1 full minute as gutta-percha is compacted laterally and somewhat apically.

C, Spreader is removed by rotation and immediately replaced by first auxiliary point previously dipped in sealer.

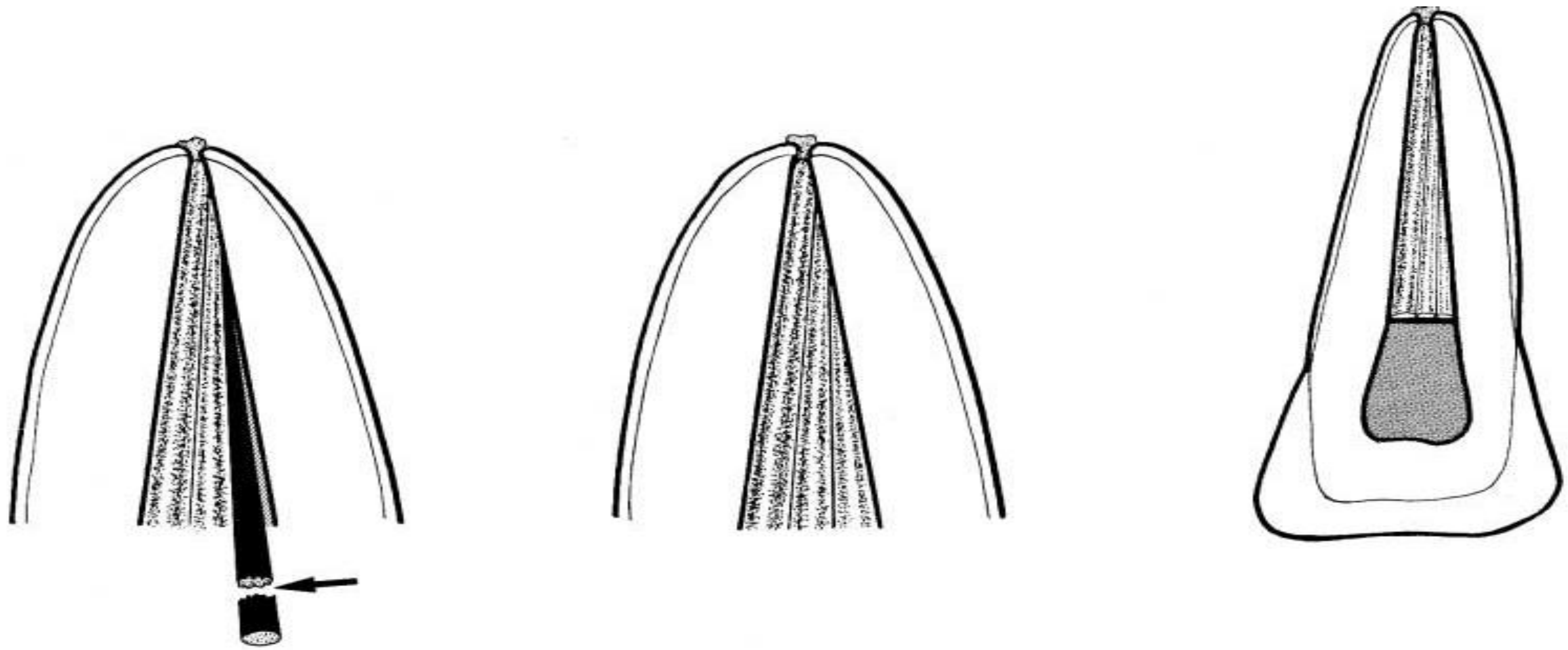


Figure 5. Lateral compaction, multiple-point filling procedure.

D, Spreader (arrow) is returned to canal to laterally compact mass of filling. Secondary vertical compaction seals apical foramen.
E, Spreader is again removed, followed by matching auxiliary point. Process continues until canal is totally obturated.
F, All excess gutta-percha and sealer are removed from crown to below free gingival level. Vertical compaction completes root filling. After an intraorifice barrier is placed, a permanent restoration with adhesives is placed in crown.

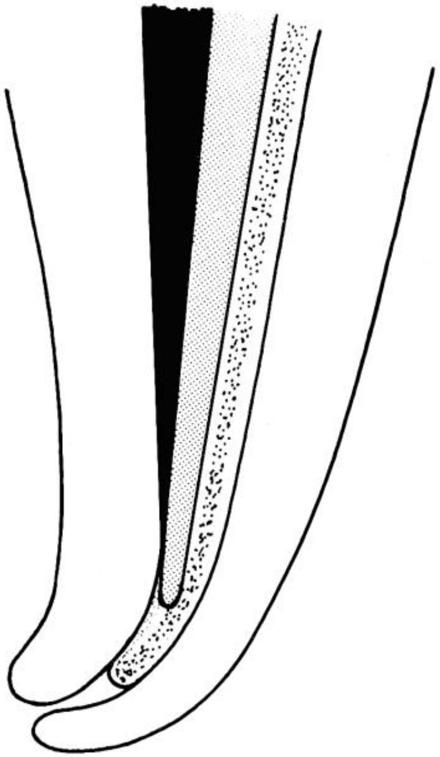


Figure 6. Lateral compaction of primary gutta-percha point in curved canal. Spreader catches into point, forcing it apically. Extra vertical compaction must be compensated for.

Figure 7. Complete root canal obliteration using multiple point technique.
Notice density of gutta-percha mass. Filling conforms exactly to size and shape of last endodontic instrument used.

Phase3: Obturation

Methods of obturating the root canal space

II. Apical-third filling

A. Lightspeed Simplifill
B. Dentin-chip
C. Calcium hydroxide

I. Solid core gutta-percha with sealer

A. Chemically plasticized cold gutta-percha
B. Cold gutta-percha points
C. Canal-warmed gutta-percha
D. Thermoplasticized gutta-percha

III. Injection or spiraling filling

A. Cements
B. Pastes
C. Plastics
D. Calcium phosphate

Phase3: Obturation

I. Solid core gutta-percha with sealer

C. Canal-warmed gutta-percha

1. Vertical compaction
2. System B compaction (Continuous wave of obturation), SybronEndo or Calamus Dual.
3. Sectional compaction
4. Lateral/vertical compaction (Endotec II, <u>tools of point no.2 can also be used here</u>)
5. Thermomechanical compaction
    - a. Microseal System, TLC, Engine-Plugger, and Maillefer Condenser
    - b. Hybrid Technique
    - c. J.S.-Quick-Fill
    - d. Ultrasonic plasticizing

Vertical compaction

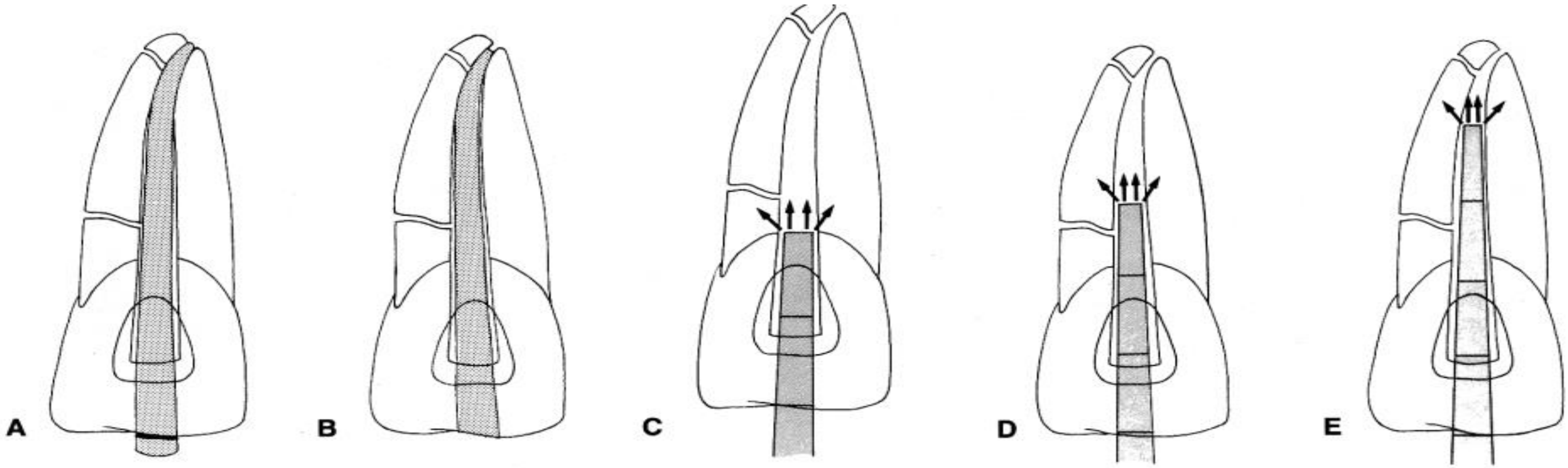


Figure 9. Technique of warm gutta-percha/vertical compaction.

A,Master gutta-percha cone fits tightly to radiographic apex. Marked at incisal edge to establish length reference.
B, Master cone cut back 0.5 to 1.0 mm at tip and retried in canal. Trimmed incisal reference remains same.
C, Largest plugger prefit to coronal third of canal.
D, Midsize plugger prefit to midcanal without touching walls.
E, Smallest plugger prefit to within 3 to 4 mm of radiographic apex. Remains free in canal.

Vertical compaction

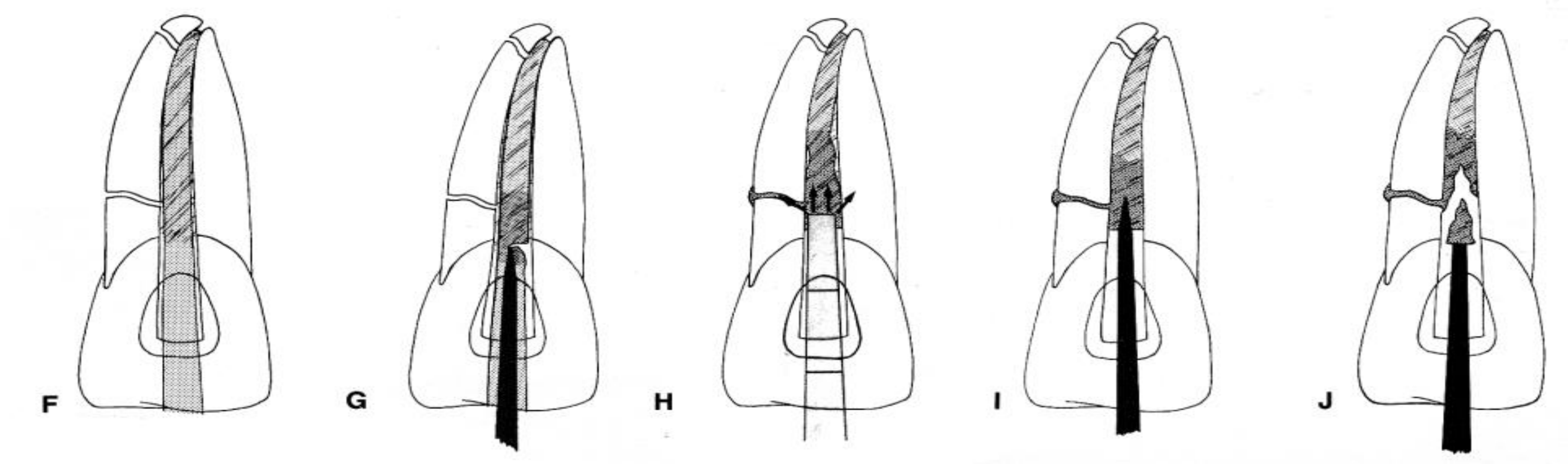


Figure 9. Technique of warm gutta-percha/vertical compaction.

F, Kerr Sealer deposited in midcanal with Handy Lentulo spiral. Apical third of master cone is lightly coated with sealer and gently teased to place. Incisal reference checked.
G, Surplus gutta-percha removed with heat carrier down to canal orifice.
H, Largest plugger compacts warmed gutta-percha into bolus. Midroot lateral canal being obturated.
I, Heat carrier transfers heat 3 to 4 mm into middle third of mass. Wiping carrier against walls softens excess gutta-percha.
J, First selective gutta-percha removal.

Vertical compaction

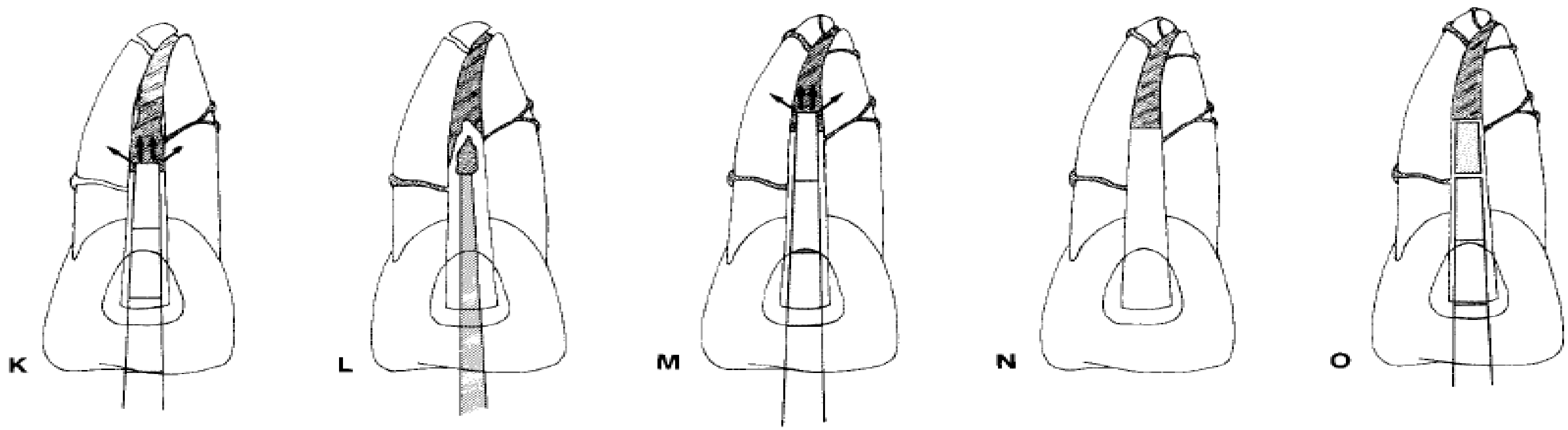


Figure 9. Technique of warm gutta-percha/vertical compaction.

K, Midsize plugger compacts heat-softened gutta-percha apically. Second lateral canal appears as obturated.

L, Heat transfer instrument warms apical gutta-percha. Second selective removal of material.

M, Smallest plugger compacts apical mass into apical preparation and accessory canals now appear obturated as well.

N, Plugger folds surplus gutta-percha around walls into flattened central mass. Radiograph confirms total obturation of apical third of canal. If a post is to be placed, obturation is complete.

O, To complete obturation by segmented gutta-percha, a 3 mm blunted section is placed and “cold-welded” with the medium plugger to the apical mass.

Vertical compaction

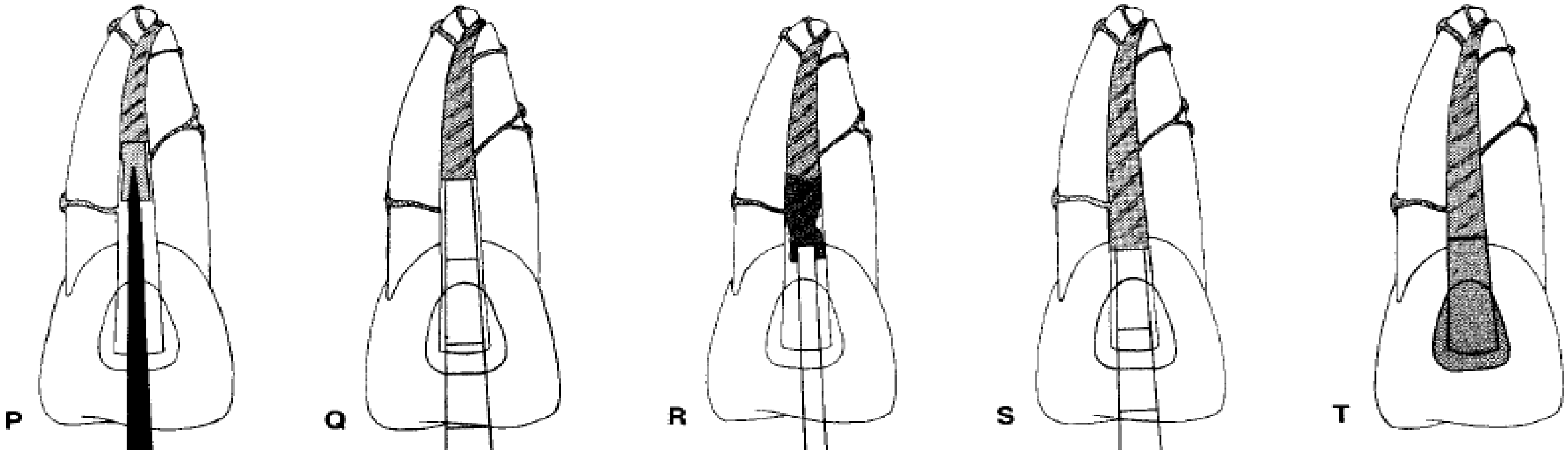


Figure 9. Technique of warm gutta-percha/vertical compaction.

P, Heat carrier warms first backpack piece.
Q, Warmed backpack piece married by compaction to apical filling. Process is continued to fill entire canal.
R, If backfill is used (for example gutta-percha gun in Obtura II), the needle is inserted to the apical segment and then backed out, leaving deposit. Plasticized gutta-percha is compacted to complete obturation to canal orifice.
S, Final compaction of backpack done with largest plugger.
T, Gutta-percha and sealer are removed to below free gingival level, crown is thoroughly cleansed, and final restoration is placed in the coronal cavity.

Vertical compaction

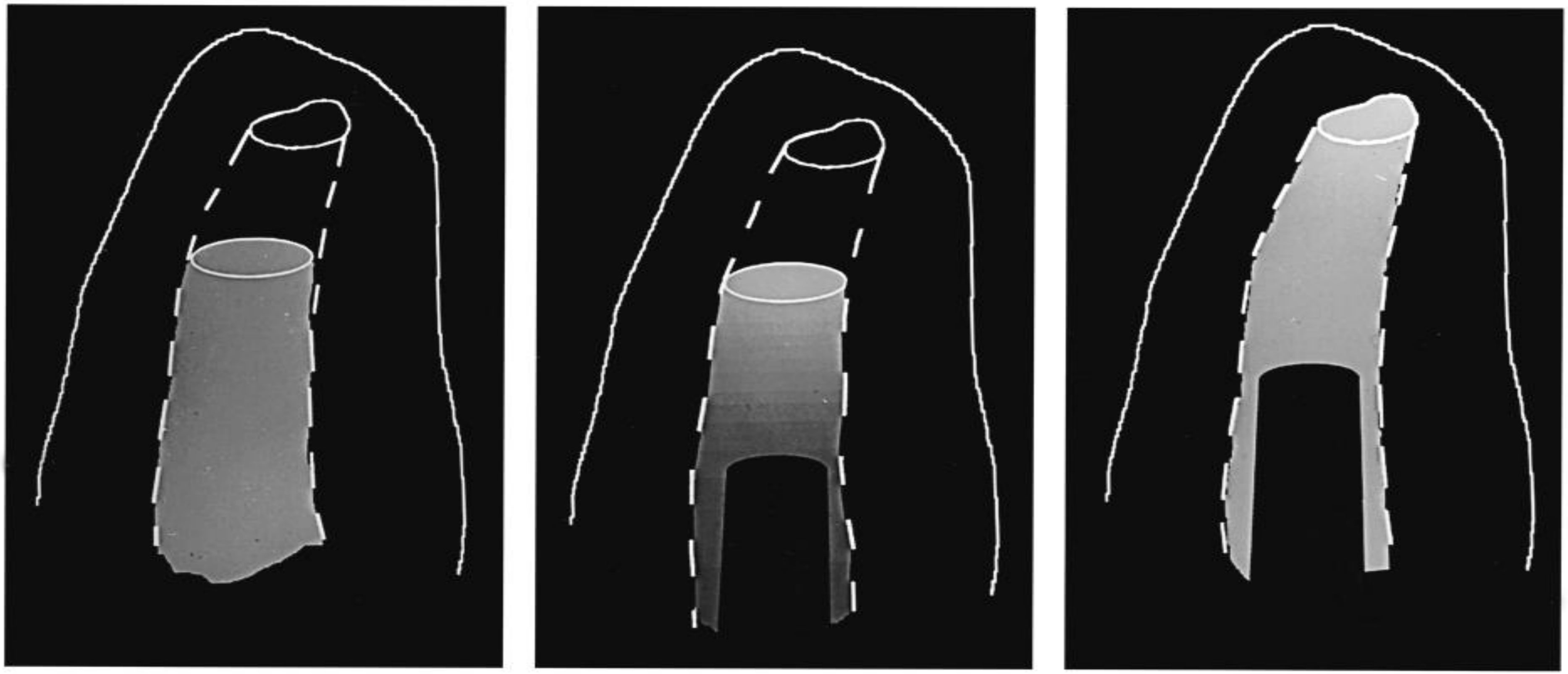


Figure 10. Warm gutta-percha conforming to “egg-shaped” canal.

A, Primary gutta-percha cone fits 0.5 to 1.0 mm short of radiographic apex.
B, Cold plugger advances the thermoplasticized gutta-percha into apical constricture.
C, Vertical pressure compacts warmed gutta-percha into nonround foramen.

Vertical compaction

Figure 11. Warm vertical condensation of the root canal space. Hydraulic forces during compaction will often obturate lateral canals.

System B compaction (Continuous wave of obturation)

Figure 12. The system B unit.

Figure 13. The System B plugger has been marked with a rubber stop. Touching the spring on the handle causes the tip to heat up instantly.

Sectional compaction

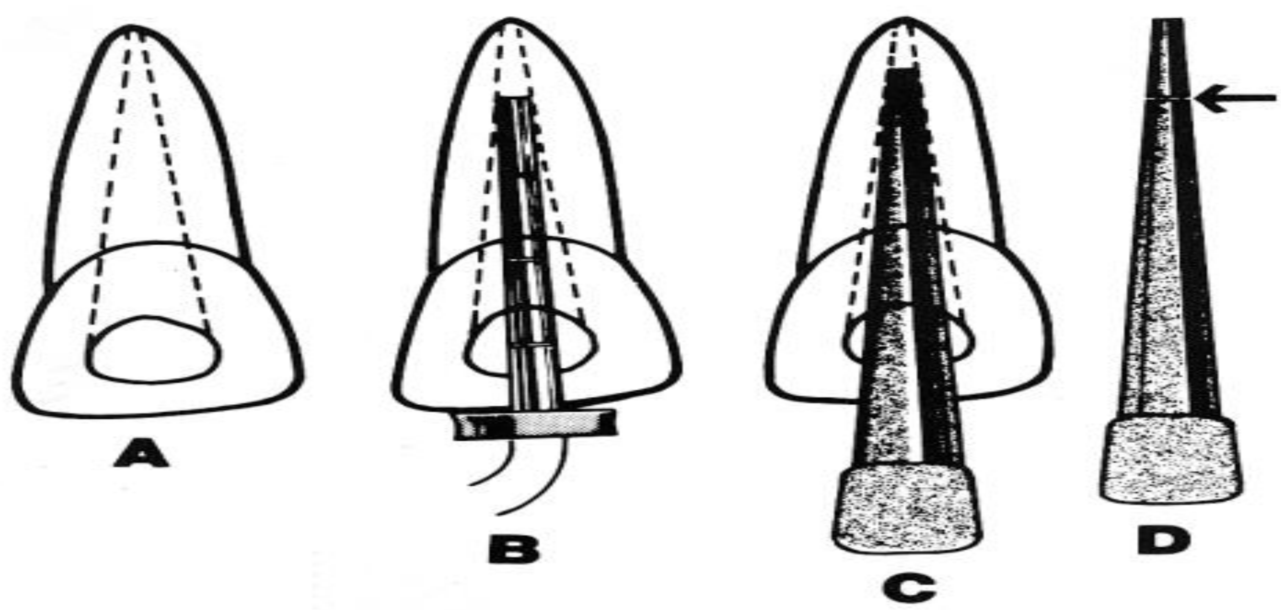


Figure 14. Sectional gutta-percha obturation.

A, Canal prepared with flare.
B, Plugger preselected to fit loosely in canal and extend to within 3 mm of working length.
C, Master gutta-percha point fitted to within 1.0 mm of working length. Confirm by radiograph.
D, Gutta-percha is removed and 3 mm of apical point are excised (arrow).

Sectional compaction

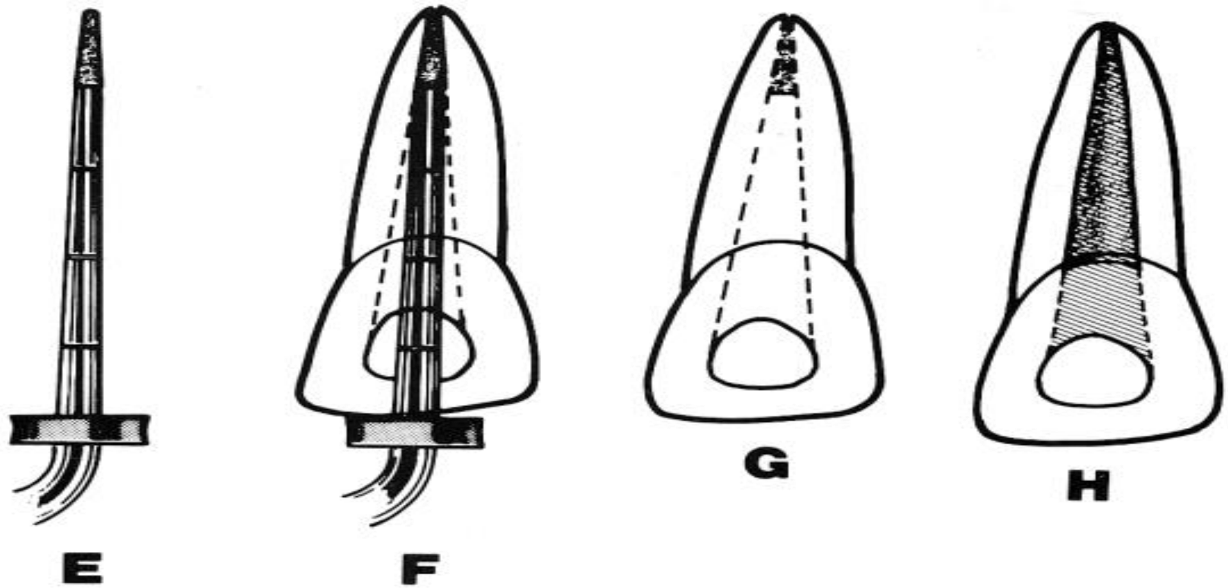


Figure 15. Sectional gutta-percha obturation.

E, Plugger is warmed in alcohol flame and point is luted to plugger. Gutta-percha is warmed by passing through alcohol flame and quickly coated with cement.
F, Warm gutta-percha is carried to place; plugger is rotated to loosen and then used for compaction.
G, Radiograph should confirm well-condensed apical filling.
H, Remainder of canal is filled by lateral or vertical condensation, by Compactor or Obtura.

Lateral/vertical compaction (Endotec II)

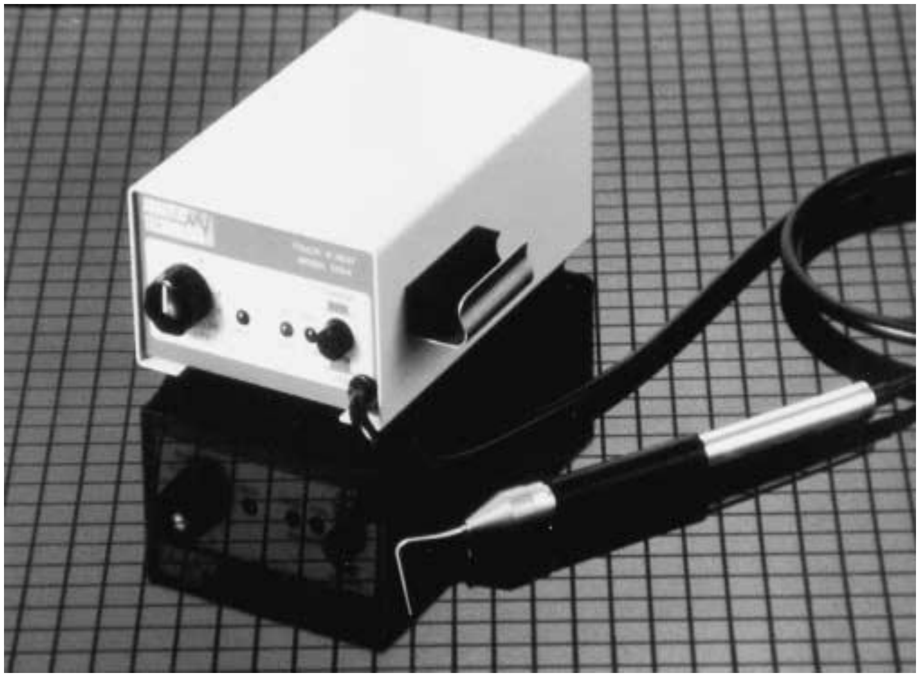


Figure 16. “Touch ’n Heat” 5004, battery-powered (rechargeable) heat source. Heat carrier heats to glowing within seconds to plasticize gutta-percha in canal. Also used in removal of gutta-percha for postpreparation or re-treatment.

Figure 17. Endotec II handpiece contains battery power pack. Button initiates heat in attached plugger.

Lateral/vertical compaction (Endotec II)

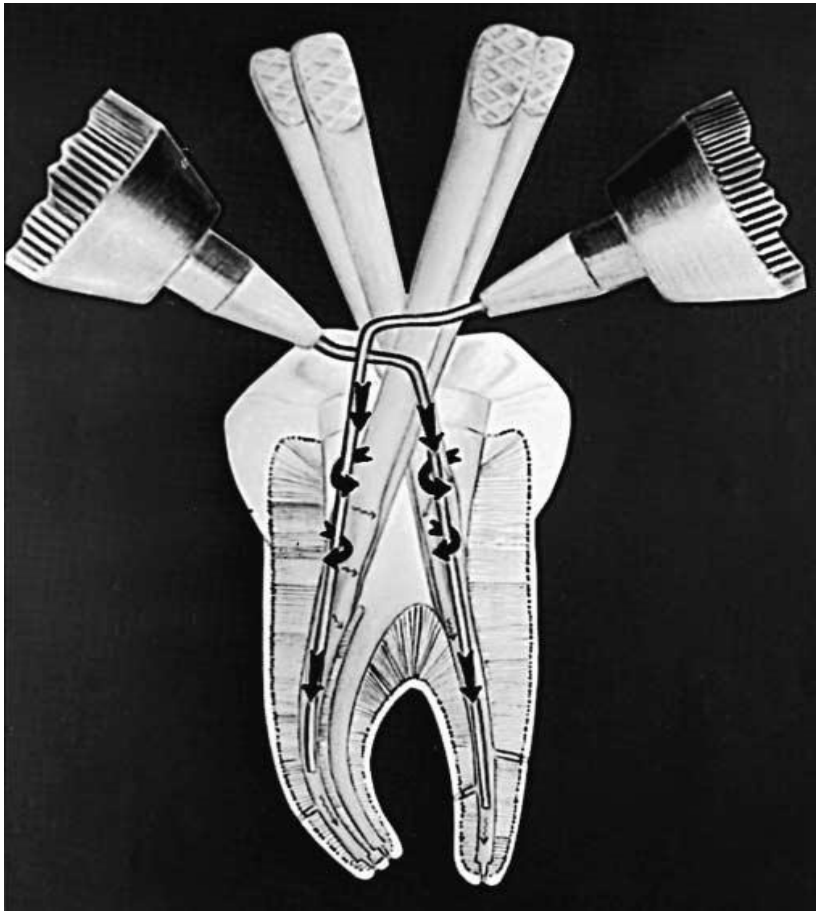


Figure 18. Motion for using Endotec II- plugger/spreader—vertical pressure with sweeping lateral pressure. Additional gutta-percha points will be added.

Thermomechanical compaction

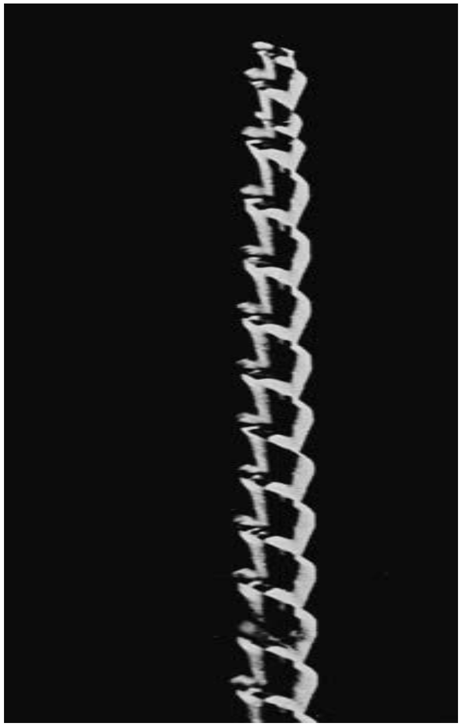


Figure 19. Micro-Seal Gutta-percha Condenser is operated at slow speed. The reverse-screw action compacts plasticized gutta-percha apically and laterally.

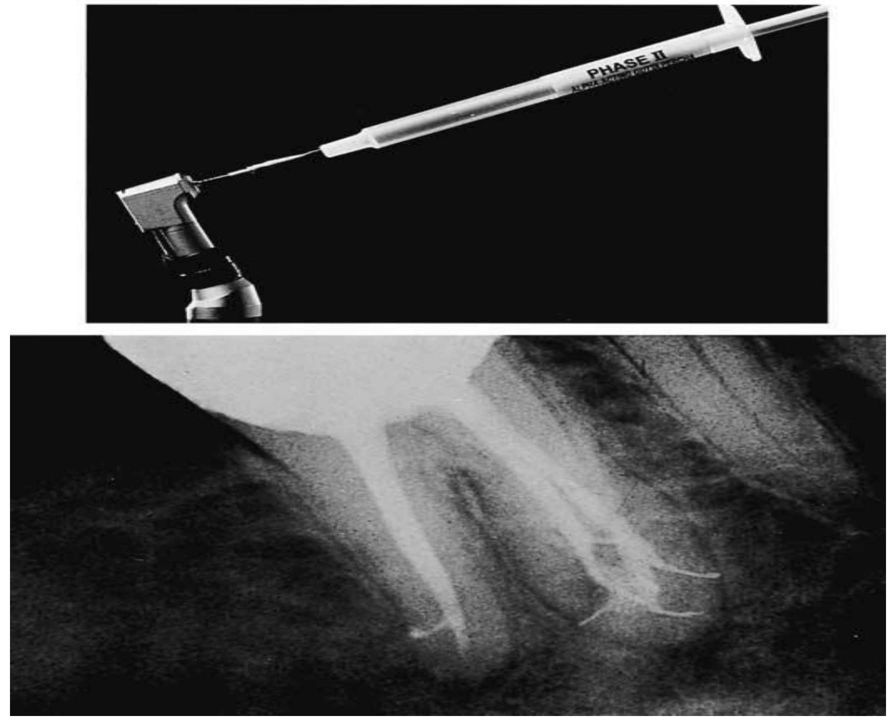


Figure 20. Loading plasticized Phase II gutta-percha onto Micro-Seal Condenser already coated with Phase I gutta-percha. B, Obturation of curved and accessory canals using Condenser and Phase I and II gutta-percha.

Thermomechanical compaction

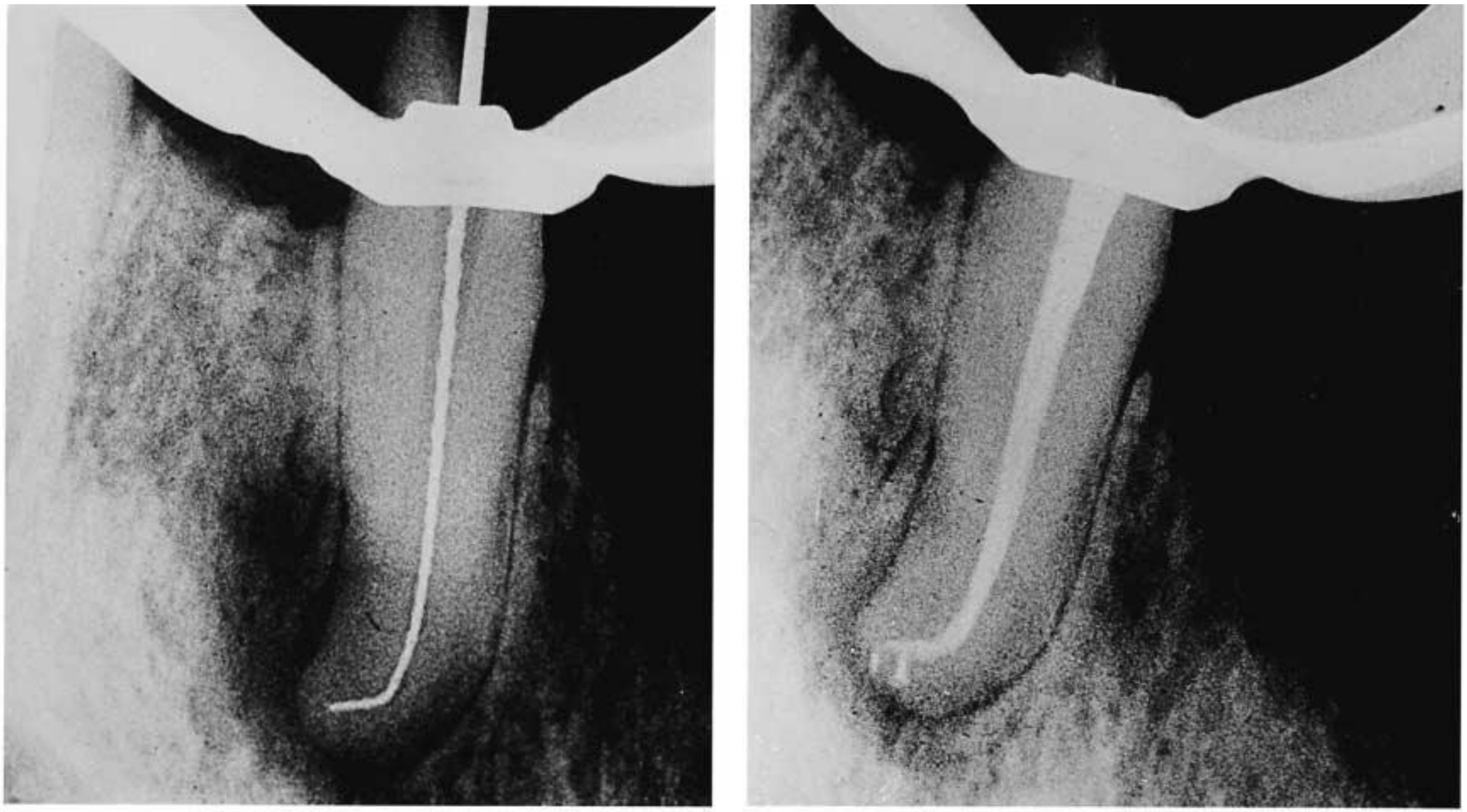


Figure 21. A, Remarkable flexibility of nickel-titanium condenser allows careful rotation in curved canals at very slow speed. B, Final filling by Condenser.

Thermomechanical compaction

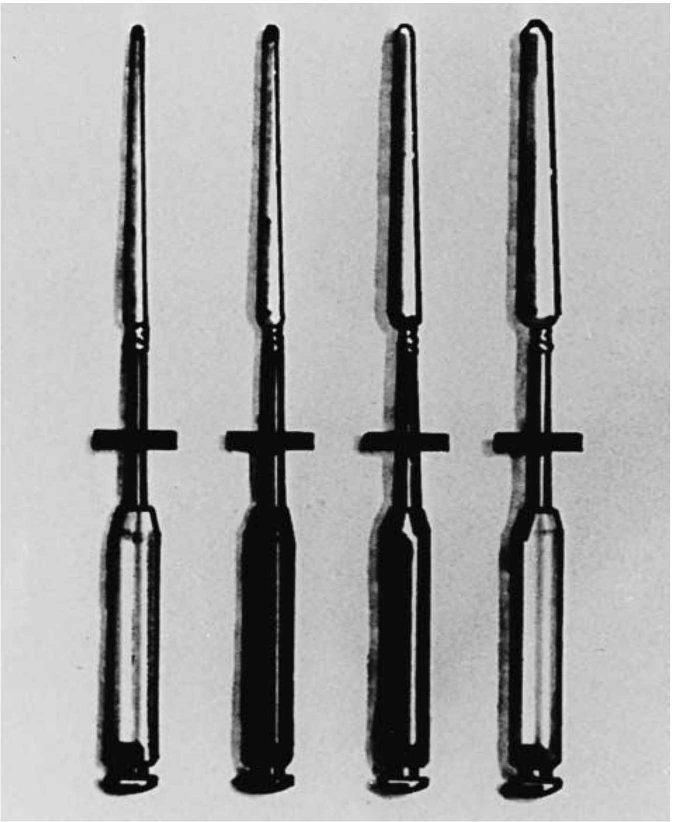


Figure 22. J.S. Quick-Fill titanium carriers coated with alpha-phase gutta-percha comes in four sizes and operates in regular slow-speed handpiece. Friction plasticizes gutta-percha. Titanium core may be severed and left (Thermafil and Densfil in Thermoplasticized gutta-percha) or removed while still spinning (Thermomechanical compaction).

Phase3: Obturation

Methods of obturating the root canal space

II. Apical-third filling

A. Lightspeed Simplifill
B. Dentin-chip
C. Calcium hydroxide

I. Solid core gutta-percha with sealer

A. Chemically plasticized cold gutta-percha
B. Cold gutta-percha points
C. Canal-warmed gutta-percha
D. Thermoplasticized gutta-percha

III. Injection or spiraling filling

A. Cements
B. Pastes
C. Plastics
D. Calcium phosphate

Phase3: Obturation

I. Solid core gutta-percha with sealer

D. Thermoplasticized gutta-percha

1. Syringe insertion (for backfill)
   a. Obtura for backfill (Obtura II)
   b. Inject-R-Fill for backfill (SybronEndo, Calamus or Calamus Dual)
2. Solid-core carrier insertion
   a. Thermafil and Densfil
   b. Soft Core and Three Dee GP
   c. Silver points

Syringe insertion: Obtura (or Obtura II)

Figure 23. Obtura II delivery system. Panel has temperature control and digital temperature display in degrees Celsius. The pistol-grip syringe (right) extrudes plasticized beta-phase gutta-percha through flexible needle.

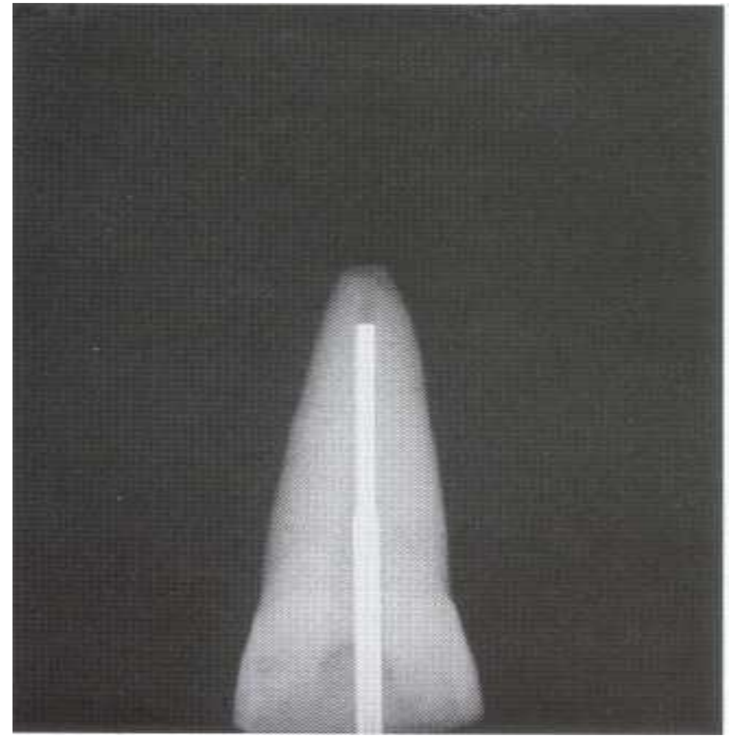


Figure 24. Prefitting of the injection-applicator tip of the Obtura II system into the apical third of the prepared canal without binding is essential for proper delivery and flow of the softened material.

Syringe insertion: Inject-R-Fill

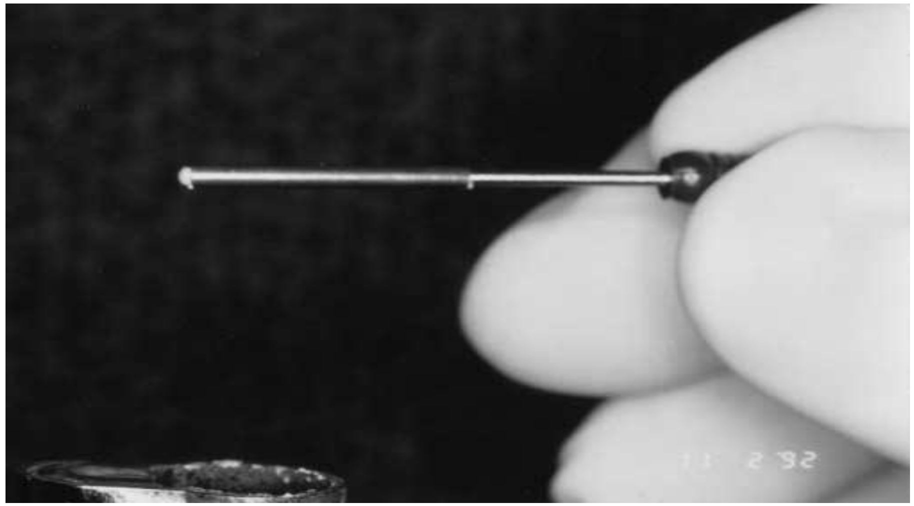


Figure 25. Inject-R-Fill shows protrusion of heat-softened gutta-percha prior to its insertion into the canal.

Syringe insertion:

1. the Obtura II is frequently used in “backfilling,” a method for completing total canal obturation after the apical third of the canal has been filled.
2. Inject-R Fill is another method of backfilling. It involves a miniature-sized metal tube containing conventional gutta-percha and plunger. The technique allows for delivery of a single backfill injection of gutta-percha once the apical segment of a canal has been obturated.

Solid-core carrier insertion: Thermafil and Densfil

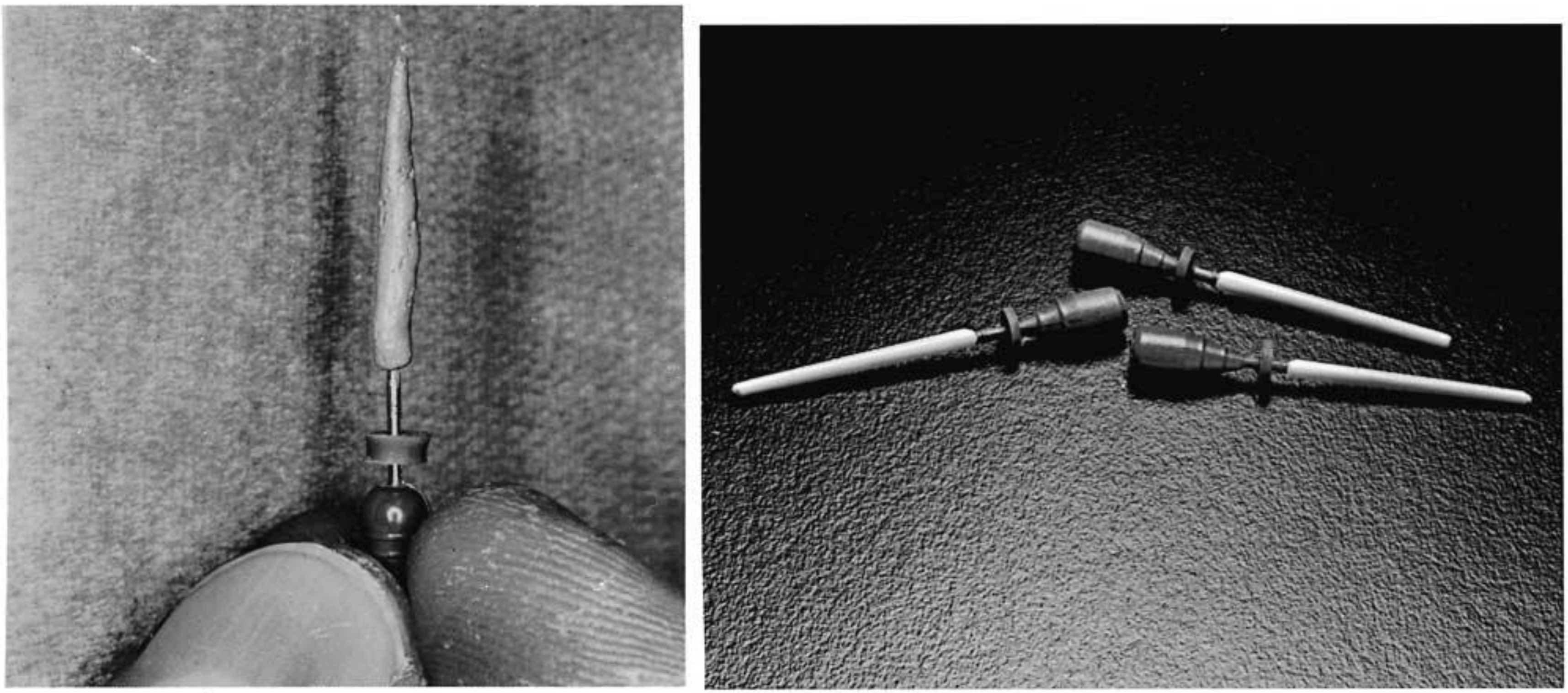


Figure 26. A, Original handmade gutta-percha obturator mounted on regular endodontic file. B, Modern manufactured Thermafil Obturators—alpha-phase gutta-percha mounted on radiopaque, flexible, plastic carriers.
Note silicone stop attachments.

Solid-core carrier insertion: Thermafil and Densfil

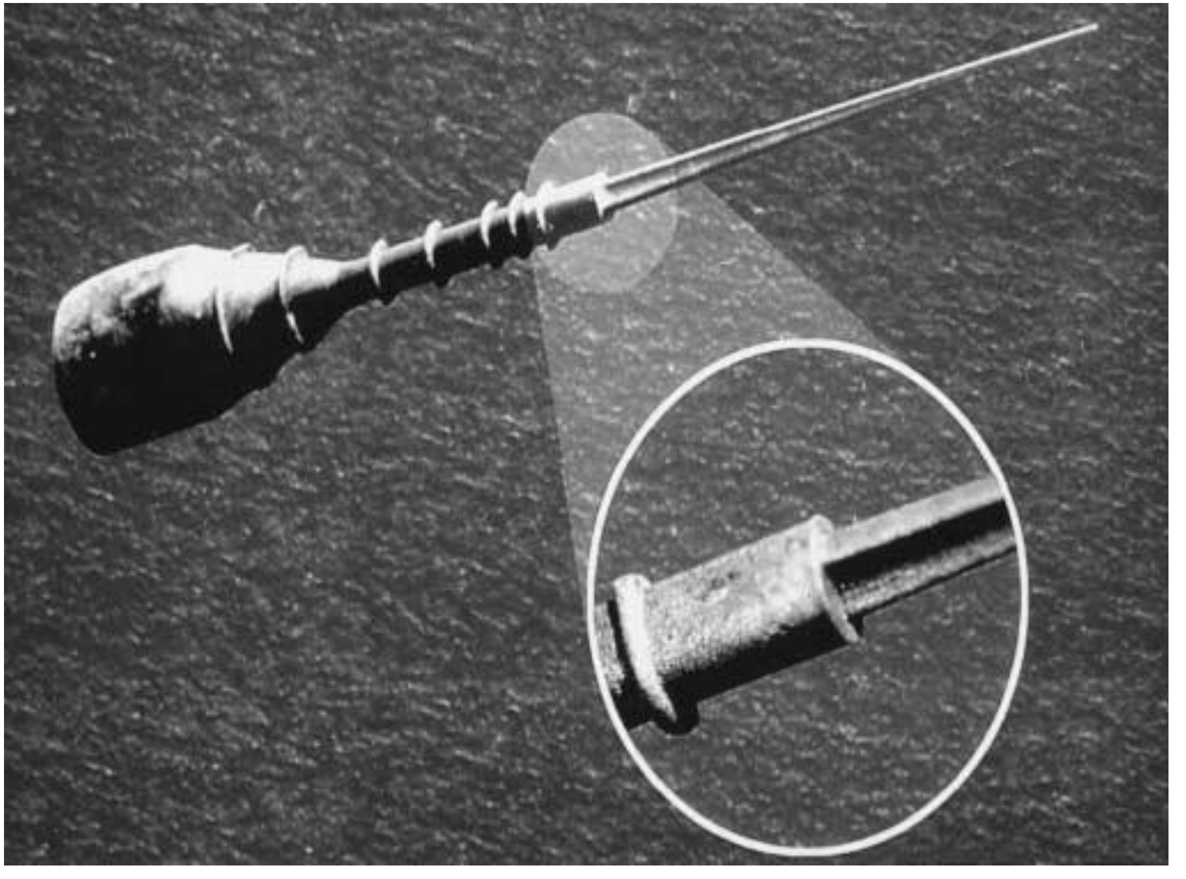


Figure 27. Details of the anatomy of the Thermafil plastic Carrier. The core is grooved to allow for the release of trapped air during the placement of the carrier. Note also the circular millimeter markings above the grooved area that facilitate length placement of the carrier.

Solid-core carrier insertion: Thermafil and Densfil

Figure 28. ThermaPrep Plus oven ensures proper softening of Thermafil Obturators within seconds.

Solid-core carrier insertion: Thermafil and Densfil

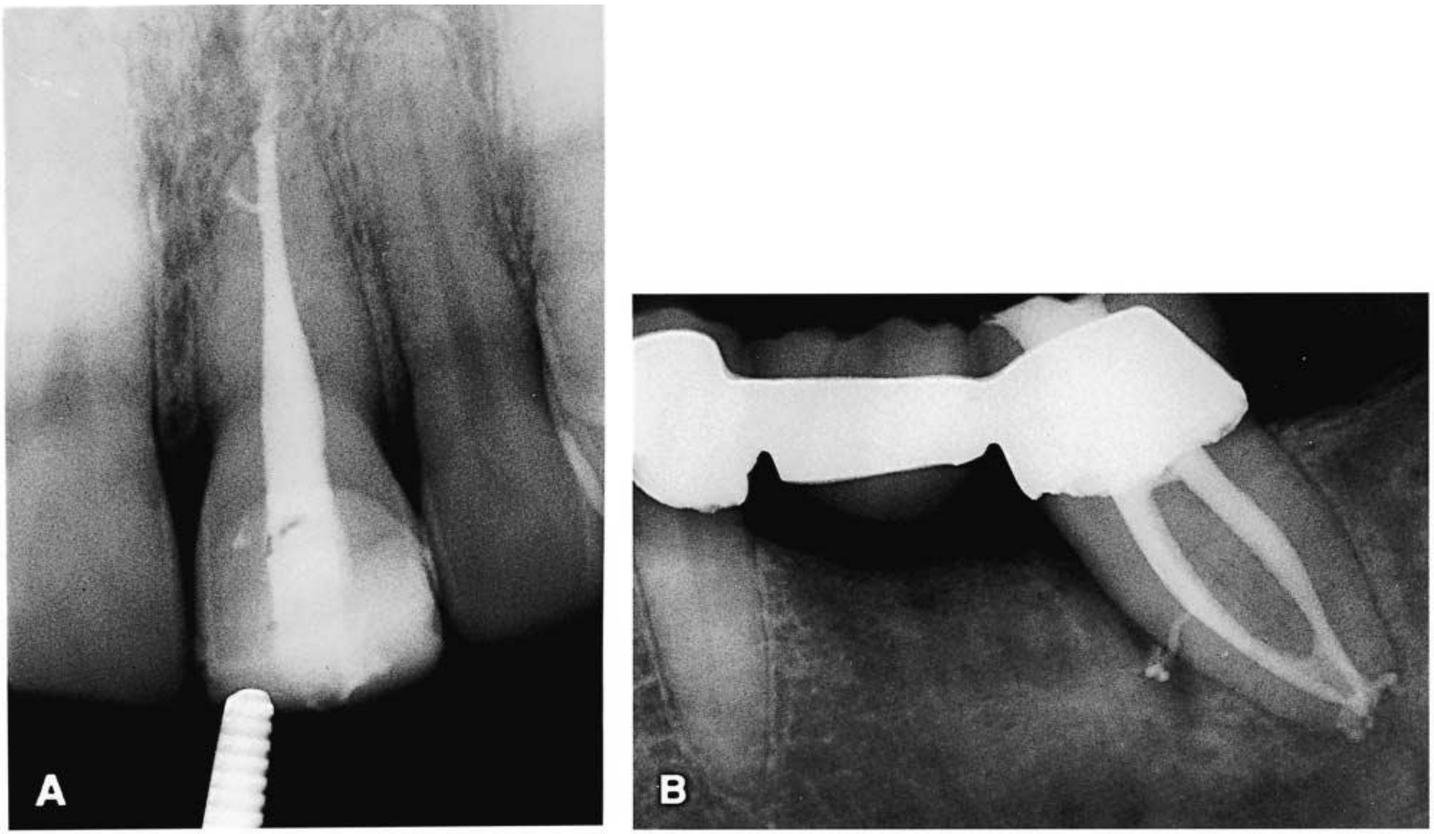


Figure 29. Obturation with Thermafil. A, Central incisor filled with size 60 Thermafil Obturator—plastic carrier. Note lateral canal near apex. B, Both mesial and distal canals filled with size 45 Thermafil Obturators—plastic carrier. Note apical fill and lateral canal.

Solid-core carrier insertion: Silver points

Figure 30. Silver cone root filling. Poorly performed silver cone obturation shows extensive corrosion (arrow) 2 years after placement.

Phase3: Obturation

Methods of obturating the root canal space

II. Apical-third filling

A. Lightspeed Simplifill
B. Dentin-chip
C. Calcium hydroxide

I. Solid core gutta-percha with sealants

A. Cold gutta-percha points
B. Chemically plasticized cold gutta-percha
C. Canal-warmed gutta-percha
D. Thermoplasticized gutta-percha

III. Injection or spiraling filling

A. Cements
B. Pastes
C. Plastics
D. Calcium phosphate

Lightspeed Simplifill

Figure 31. SimpliFill apical gutta-percha plug. Point is lightly heated and used as primary apical fill. Carrier is twisted for removal and used as plugger.

A. Dentin-chip

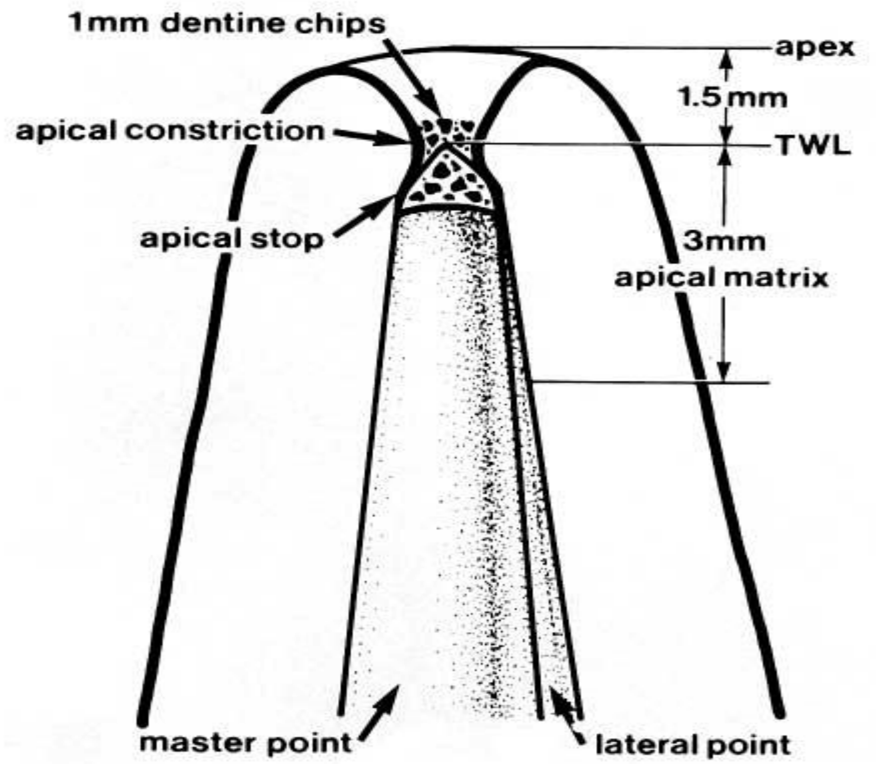


Figure 32. Dentin chips compacted into last 2 mm of preparation, spilling over from true working length (TWL) to stimulate cementogenesis. Gutta-percha and sealer complete obturation.

A. Dentin-chip

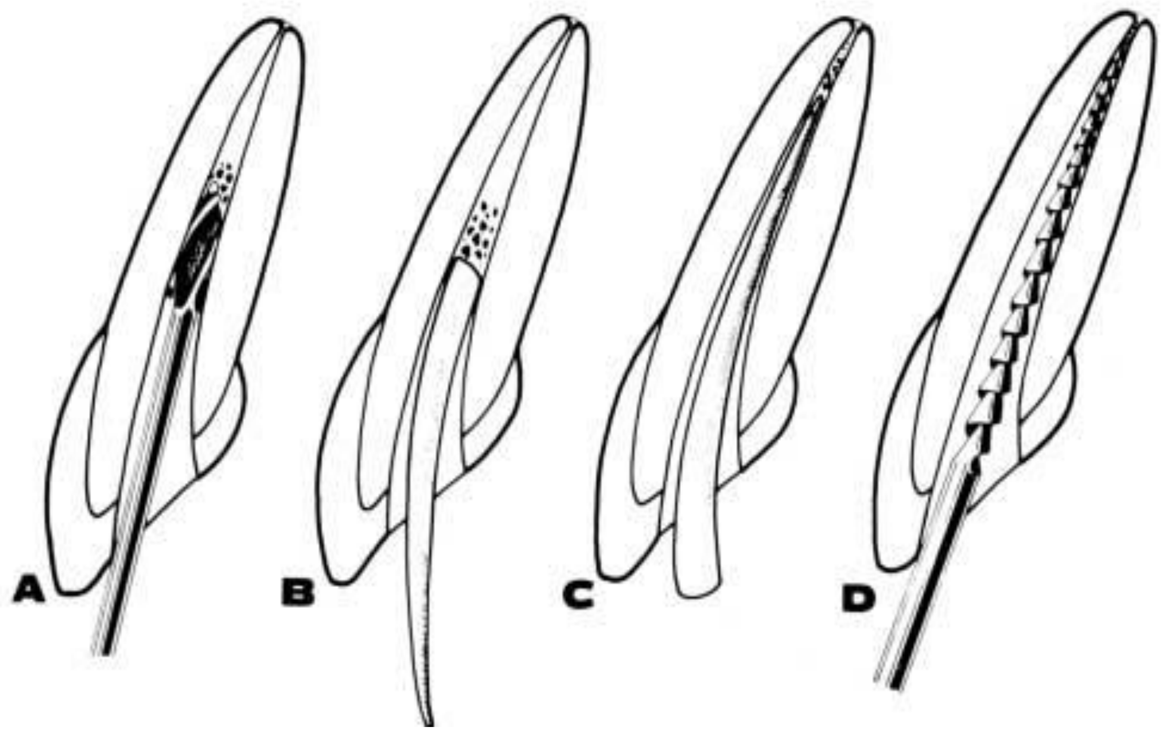


Figure 33. Dentin chip–apical plug filling.

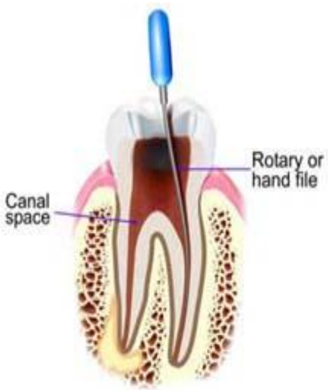
A, Clean dentin chips produced in midcanal with Gates-Glidden drill.
B, Loose chips collected and moved apically with butt end of paper point.
C, Dentin chips compacted at apical foramen with blunted paper point.
D, Final compaction with file, one size larger than last enlarging instrument.

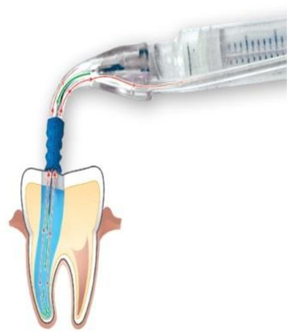
Conclusion

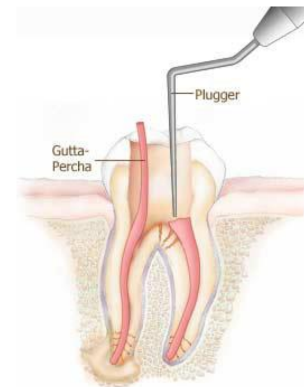
- The lateral compaction of cold gutta-percha points with sealer is the most commonly taught in dental schools and used by practitioners and has long been the standard against which other methods of canal obturation have been judged.
- Today, most root canals are being filled with gutta-percha and sealers. The methods vary by the direction of the compaction (lateral or vertical) and/or the temperature of the gutta-percha, either cold or warm (plasticized).
- The two basic procedures: lateral compaction of cold gutta-percha or vertical compaction of warmed gutta-percha. Other methods are variations of warmed gutta-percha.

Phases of root canal treatment

1 Instrumentation → 2 Irrigation → 3 Obturation







Thank you

Average working length (WL)

Teeth	Upper	Lower
Central Incisor	Average time of eruption: 7 to 8 years Average age of calcification: 10 years Average length: 22.5 mm	Average time of eruption: 6 to 8 years Average age of calcification: 9 to 10 years Average length: 20.7 mm
Lateral Incisor	time of eruption: 8 to 9 years Average age of calcification: 11 years Average length: 22.0 mm	The same as lower central incisor
Canine	Average time of eruption: 10 to 12 years Average age of calcification: 13 to 15 years Average length: 26.5 mm	Average time of eruption: 9 to 10 years Average age of calcification: 13 years Average length: 25.6 mm
1st Premolar	Average time of eruption: 10 to 11 years Average age of calcification: 12 to 13 years Average length: 20.6 mm	Average time of eruption: 10 to 12 years Average age of calcification: 12 to 13 years Average length: 21.6 mm
2nd Premolar	Average time of eruption: 10 to 12 years Average age of calcification: 12 to 14 years Average length: 21.5 mm	Average time of eruption: 11 to 12 years Average age of calcification: 13 to 14 years Average length: 22.3 mm
1st Molar	Average time of eruption: 6 to 7 years Average age of calcification: 9 to 10 years Average length: 20.8 mm	Average time of eruption: 6 years Average age of calcification: 9 to 10 years Average length: 21.0 mm
2nd Molar	Average time of eruption: 11 to 13 years Average age of calcification: 14 to 16 years Average length: 20.0 mm	Average time of eruption: 11 to 13 years Average age of calcification: 14 to 15 years Average length: 19.8 mm
3rd Molar	Average time of eruption: 17 to 22 years Average age of calcification: 18 to 25 years Average length: 17.0 mm	