Obturation of the root canal system

Microorganisms and their byproducts are the major cause of pulpal and periapical diseases. However, it is difficult to consistently and totally disinfect root canal systems. Therefore, the goal of three-dimensional (3-D) obturation is to provide an impermeable fluid-tight seal within the entire root canal system, to prevent oral and apical microleakage.
Assessment of nonsurgical treatment is based primarily on the post-treatment radiographic examination. The following four factors influenced the success of treatment, including the absence of a periapical lesion (PL), root canal obturations containing no radiographic voids, obturation to within 2.0 mm of the radiographic apex, and adequate coronal restoration.

Objectives of canal obturation

1. Elimination of coronal leakage of microorganisms or potential nutrients to support their growth in the dead space of the root canal system.
2. To confine any residual microorganisms that have survived the chemo-mechanical cleaning and shaping, to prevent their proliferation and pathogenicity.
3. To prevent percolation of periapical fluids into the root canal system which could provide feeding for residual microorganisms.
4. Creation of a favorable biological environment for the process of tissue healing.

Timing of obturation

1. Patient symptoms: Sensitivity on percussion indicates inflammation of periodontal ligament space, therefore, the canal should not be obturated before the inflammation has subsided.
2. Pulp and periradicular status:
   A. Vital pulp tissue: in this case, obturation can be done in a single visit after complete cleaning and shaping.

B. Necrotic pulp tissue:
   Single-visit endodontics can be done if the tooth is asymptomatic. If the tooth is symptomatic, such as tenderness to percussion, purulent exudate, or presence of sinus tract, it indicates an active inflammatory condition of the periapical region. Therefore, the canal should be obturated after the inflammation has subsided.

3. Negative culture: dependence on negative culture has decreased now, because it may give false indications about the exact inflammatory condition.

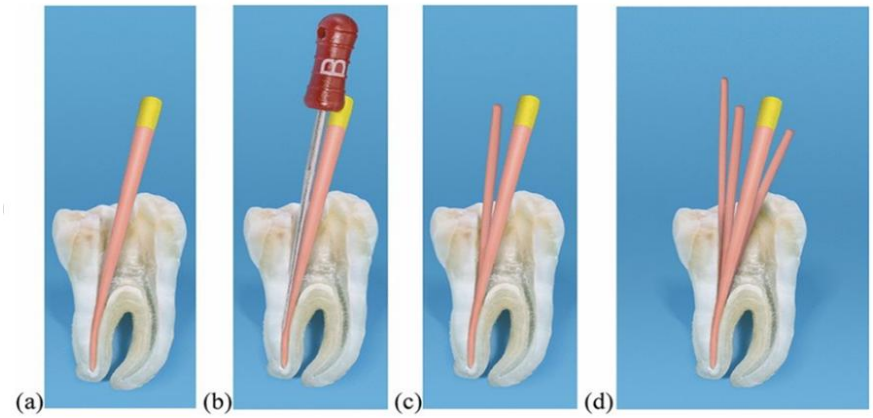
Heat-softened gutta percha techniques

A. <u>Warm lateral compaction</u>

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, with fewer voids and more dimensional stability.

<u>Technique:</u>

1. The root canal is cleaned and shaped properly
2. Fit the master cone to full working length with slight resistance to withdrawal (tugback).
3. Insert a hot spreader laterally into the master cone to soften gutta percha and create space for the accessory cones.
4. Insert the accessory cone and repeat the procedure until the canal is completely filled.
5. An electrically heated spreader may be used.



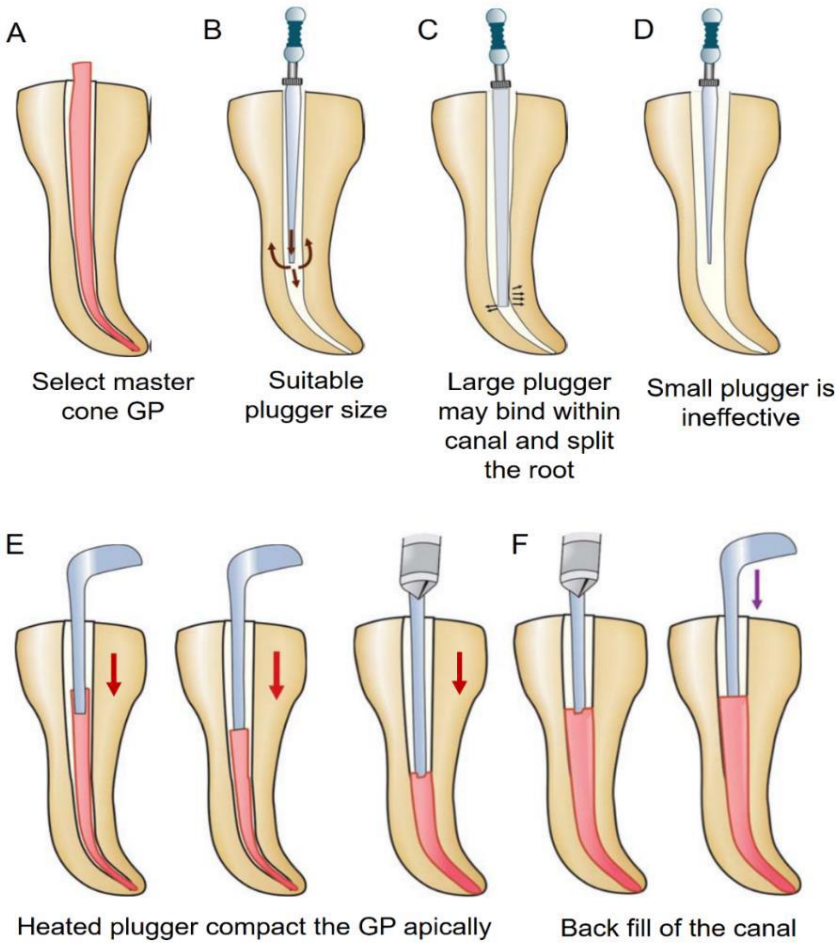
Clinical steps of cold lateral compaction technique using master and accessory GP points and finger spreader

B. Warm vertical gutta percha filling technique

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

Technique:

1. Select a master cone according to the shape and size of the prepared canal. The cone should fit in 1–2 mm of the apical stop because when softened material moves apically into the prepared canal, it adapts better to the canal walls.
2. Select the heat-transferring instrument and pluggers according to canal shape and size. Pluggers are pre-fitted at 5 mm intervals to capture the maximum cross-section area of the softened gutta-percha.
3. Lightly coat the canal with sealer.
4. Cut the coronal end of the selected gutta-percha and insert it into the canal until reaching the exact length.
5. A plugger is inserted into the canal and the gutta-percha is compacted, forcing the plasticized material apically.
6. The process is repeated until the apical portion has been filled.
7. The coronal canal space is back-filled, using small pieces of gutta-percha. The sectional method consists of placing 3-4 mm sections of gutta-percha with approximating size into the canal, applying heat, then compacting the mass with a plugger.



C. Continuous Wave Compaction Technique



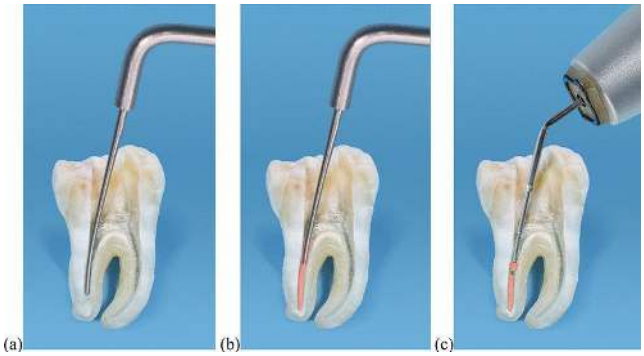
It is a variation of warm vertical compaction. The manufacturing of cones to mimic the tapered preparation, using rotary instrumentation, permits the application of greater hydraulic force during compaction when appropriately tapered pluggers are used. The continuous wave compaction technique employs System B connected to 0.04, 0.06, 0.08, 0.10, or 0.12 tapered stainless steel dead-soft pluggers.

Technique:

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

2. Confirm the fit of the gutta-percha cone, then cut the tip of the master cone gutta-percha 0.5mm short of working length, and apply sealer in the canal.
3. With System B turned on to “use,” place it in touch mode, and set the temperature at 200°C.
4. Place the master cone into the canal and cut the excess at the canal orifice with a pre-heated plugger, then push the plugger on the softened gutta-percha to push it 3-4mm apically.
5. Then release the heating switch and hold the plugger here for 10s with sustained pressure to take up any shrinkage that might occur upon cooling of gutta-percha.
6. Maintaining the apical pressure, activate the heat switch for 1 sec followed by a 1 sec pause, and then remove the plugger.
7. After removal of the plugger, introduce a small flexible end of another plugger with pressure to confirm that the apical mass of gutta-percha has cooled, set, and not dislodged. Following radiographic confirmation, the canal is ready for the backfill by any means.





<u>Advantages</u>:

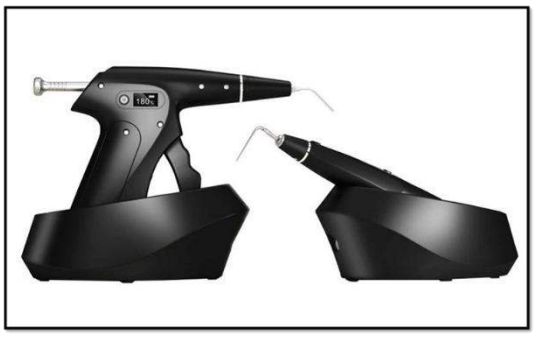
1. Compaction of filling material can be done at the same time when it has been heat softened.
2. Excellent apical control.
3. Fast, easy, predictable.
4. Thorough condensation of the main canal and lateral canals.
5. Compaction of obturating materials occurs at all levels simultaneously throughout the momentum of heating and compacting instruments apically.

D. Thermoplastic Injection Techniques

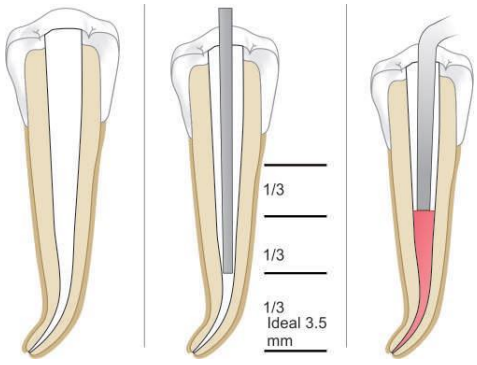
Heating of gutta-percha outside the tooth and injecting the material into the canal is an additional variation of the thermoplastic technique. This technique is used to obturate irregularities difficult to fill by other techniques such as internal resorption or for backfill after apical filling. The obtura III, Calamus, Ultradent and Guttaflow devices and systems are examples of this type. The obtura III system consists of a handheld "gun" that contains a chamber surrounded by a heating element into which pellets of GP are loaded. Silver needles (varying gauges of 20, 23, and 25) deliver the thermoplasticized material into the RCS. The regular β-phase of gutta-percha is used in this technique which comes in pellets.

Technique:

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 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 can be expected by this procedure.







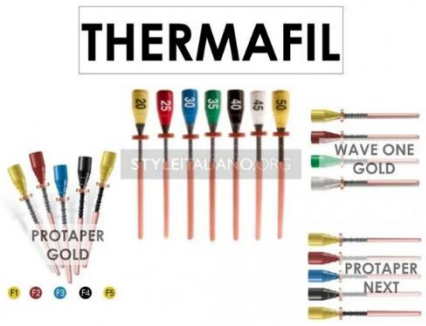
E. Carrier-Based Gutta-Percha

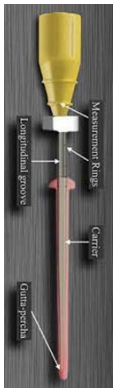
Thermafil and Soft Core cones were introduced as a gutta-percha obturation material with a solid core. The technique has a central plastic core that facilitates the adaptation of the α-phase gutta-percha to the root canal walls apically and laterally.

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

Technique:

1. Size verifiers should fit passively at the corrected working length.
2. Removal of the smear layer is strongly recommended because it enhances the seal.
3. After drying the canal a light coat of sealer is applied and a carrier is marked, set to the predetermined working length.
4. The carrier is disinfected with 5.25% NaOCl for 1 minute and rinsed in 70% 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 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, eucalyptol, 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

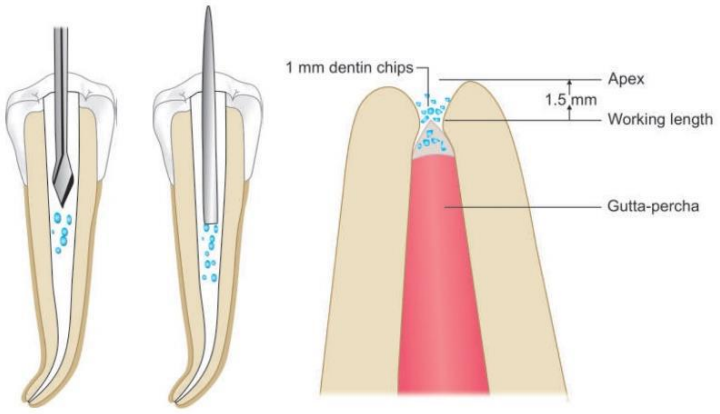
Pastes have some requirements of the root canal obturating materials. They can adapt to the complex internal canal anatomy; however, the flow characteristic can result in extrusion or incomplete obturation. The inability to control the material is a distinct disadvantage, and, when extrusion occurs, it is possible that it can be corrected only by surgical intervention. In addition, 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 external apical root resorption and where instrumentation extends beyond the confines of the root. However, in teeth with immature root apex, the treatment procedure should promote apical root formation rather than apical closure with filling. These techniques include root apexification, vital pulp therapies, or revascularization.

Several materials 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 biological seal to enhance healing. Contaminated dentin with bacteria decreases the success of this 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 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. **<u>Pulp regenerative techniques including revascularization</u>**: This technique aims to regenerate the vitality of the pulp to increase the thickness of the canal walls and induce apical root development and root apex formation.

   <u>Technique</u>:

   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.

