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Review Article

New Root Canal Obturation Techniques: A Review

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Abstract

Successful root canal treatment is based on diagnosis, treatment planning, knowledge of tooth anatomy, and the traditional concepts of debridement, sterilization, an obturation. Several obturation techniques are available for root canal treatment. The choice depends on the canal anatomy and the unique objectives of treatment in each case. The two basic obturation procedures are lateral condensation and warm vertical condensation. The advent of new devices and techniques, such as those utilize heat, and vibration for warm lateral and warm vertical condensation, are revolutionizing the practice of endodontics and making obturation procedures more predictable. Aim of this article is to know about the types of devices available for the application of heat and/or vibration during root canal obturation and the rationale for their use and new obturating material available for successful root canal treatment.

Keywords: *Obturation; Dentin; Smear Layer; Gutta-Percha; Heat*

Introduction

Successful root canal treatment is based on diagnosis, treatment planning, knowledge of tooth anatomy and the traditional concepts of debridement, sterilization, and obturation [1]. Adequate access and a straight-line path to the canal system allow complete irrigation, shaping, cleaning, and quality obturation [2]. Root canal treatment is predictably successful with careful cleaning, and shaping of the canal system, three dimensional obturation and well-fitting coronal restoration [3]. Regardless of the obturation method, emphasis has to be placed on the process of cleaning and shaping the root canal [4]. Smear layer produced during instrumentation may interfere with adhesion and penetration in to dentinal tubules of intracanal medicament or root canal sealer during obturation [5]. Prior to obturation smear layer should be removed and dentin interface thoroughly dried.

Various experimental methods have been used to assess micro leakage fallowing obturation, including the use of radioisotopes, dyes, proteins, bacterial leakage, and endotoxin penetration, as well as the use of the electrochemical, fluometric, and scanning electron microscopic examination, and spectrophotometry [4-14]. Many studies highlights the need for, improved canal cleaning, shaping and obturation techniques [15].

Objectives of this review paper

1. Understand the requirements for successful obturation of root canals
2. Be knowledgeable concerning available root canal obturation materials, and what constitutes ideal root canal filling material.
3. Understand the basic techniques and their steps for root canal obturation
4. Be knowledgeable about the types of devices available for the application of heat and/ or vibration during root canal obturation and the rationale for their use.

Root canal obturating materials

In 1941 Jasper introduced silver cones [16]. Their rigidity made them easy to place, however their inability to fill the irregularly shaped root canal system permitted leakage. Silver points were found to corrode and the corrosion products were found to be highly cytotoxic [17]. Thus, silver points are no longer utilized for root canal obturation.

For many years gutta-percha has been used and being used and when used with root canal sealer it is an successful root canal filling material. Sealers fill voids, lateral and accessory canals [18]. Some of the obturating materials are based on dentin adhesion technology in order to seal the root canal system more effectively and strengthen the root. However, it is challenging due to root canal anatomy and limitations in the physical and mechanical properties of the adhesive materials [19-21]. Although there is no ideal obturating material, Grossman outlined the requirements for an ideal root canal filling material [18].

Gutta-percha can be made to flow using heat or using solvents such as chloroform or eucalyptus as well as by ultrasonics and vibration. Gutta-percha is trans-isomer of polyisoprene and exists in two crystalline forms, (alpha and beta) with differing properties. The use of alpha phase gutta-percha has increased as thermoplastic techniques have become more popular. Gutta-percha cone size uniformity in manufacturing has improved and the actual cone size is more precise [22-24]. Gutta-percha points can be sterilized before use by placing the cones in 5.25% NaOcl for 1 minute [25].

Resin based Resilon is a high performance industrial polyurethane, adapted for endodontic use. It resembles gutta-percha and can be manipulated similarly. It consists of a resin core material available in conventional/standardized cones or pellets and a resin sealer. Resilon is nontoxic, non-mutagenic, and biocompatible.

Calcium hydroxide, dentin plugs, and hydroxyapatite have been advocated for placement as barriers in canals exhibiting an open apex to permit obturation, while minimizing extrusion of materials in to the periradicular tissues. Teeth treated with calcium hydroxide for prolonged periods have recently been found to be more susceptible to fracture. Placement of an apical barrier and immediate obturation is an alternative to apexification. Mineral trioxide aggregate (MTA) has been suggested as an apical barrier material. MTA is sterile, biocompatible and capable of inducing hard tissue formation. The material is compacted in to the apical portion of the root and allowed to set and then gutta-percha can be compacted without extrusion. This technique is quick, and clinically successful, and eliminates the need for numerous visits and possible recontamination during apexification.

Obturation Techniques: Several obturation techniques are available for root canal treatment. The choice depends on the canal anatomy and the unique objectives of treatment in each case. Lateral condensation and warm vertical condensation of gutta-percha are techniques that have passed the test of time. Newer methods includes the use of injectable, thermoplasticized gutta-percha systems, carrier coated with an alpha phase gutta-percha, cold flowable obturation materials that combine gutta-percha and sealer in one product and Glass Ionomer embedded gutta-percha cones. Two basic obturation procedures are lateral condensation and warm vertical condensation.

Lateral Cold Condensation: This technique has been the gold standard to which other techniques have been compared. Lateral cold condensation has the advantage of excellent length control and can be accomplished with any of the acceptable sealers. However, this technique may not fill canal irregularities as well as the, warm vertical compaction technique.

Figure 1: *Resilon Epiphany.*

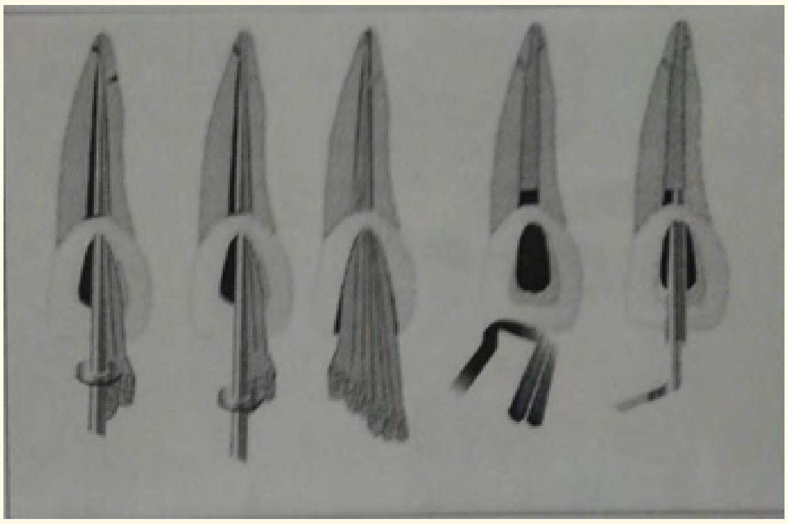

Figure 2: *Lateral cold condensation.*

Use of vibration, heat and ultrasonics: An alternative to cold lateral compaction with finger spreaders is ultrasonics and more recently, a combination of vibration and heat using the DownPak obturation device. It has been found that an ultrasonic condensation technique produced adequate obturation and clinical success rate. Lateral condensation can be employed by alternating heat after the placement of each accessory gutta-percha cone. Heat can soften the cone for better condensation and homogenicity of gutta-percha.

Warm vertical condensation: Vertical condensation of gutta-percha forms the basis for many techniques, such as the master cone sectional, warm gutta-percha, and thermoplasticized techniques. A master cone is fitted short of the corrected working length with resistance to displacement. A heated plugger is inserted in to the canal and gutta-percha condenses, forcing the plasticized material apically. The process is repeated until the apical portion has been filled. The coronal space is back filled using small segments of gutta-percha by placing in to the root 3 - 4 mm sections approximately the size of the canal, applying heat, and condensing the gutta-percha with a plugger.

It has been found that a higher percentage of the canal area is filled with gutta-percha in oval canals using the warm vertical condensation technique. Advantage of warm vertical compaction technique include movement of the plasticized gutta-percha and filling of canal irregularities and accessory canals. It is difficult to obturate curved canals with this technique. Disadvantage include risk of vertical root fracture and extrusion of material in to the periradicular tissues.

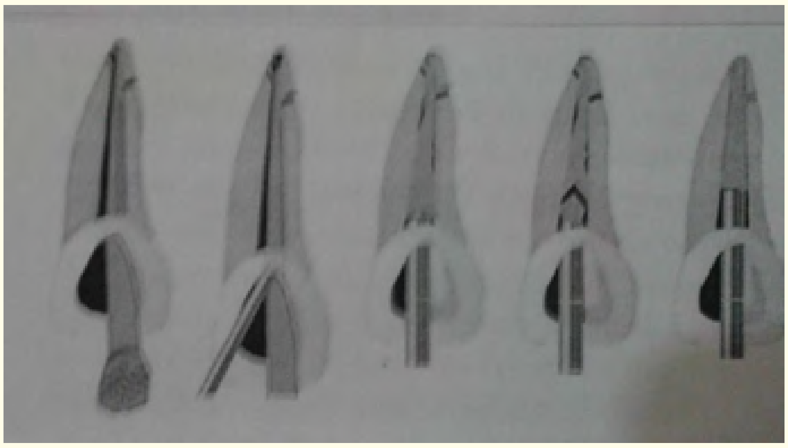

Figure 3: *Warm vertical condensation.*

Temperature Control: The Down Pak cordless obturation device as well as the system B and Touch "n" Heat devices are alternatives to applying heat with a flame heated instrument because they permit temperature control. Root surface heat greater than 10°C produce irreversible bone damage. Caution should be exercised with the Touch "n" Heat temperature setting.

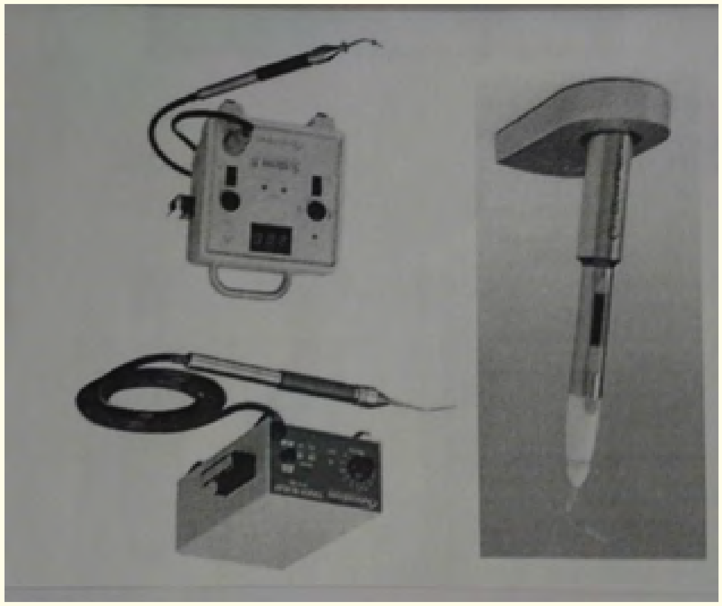

Figure 4: *Temperature control devices.*

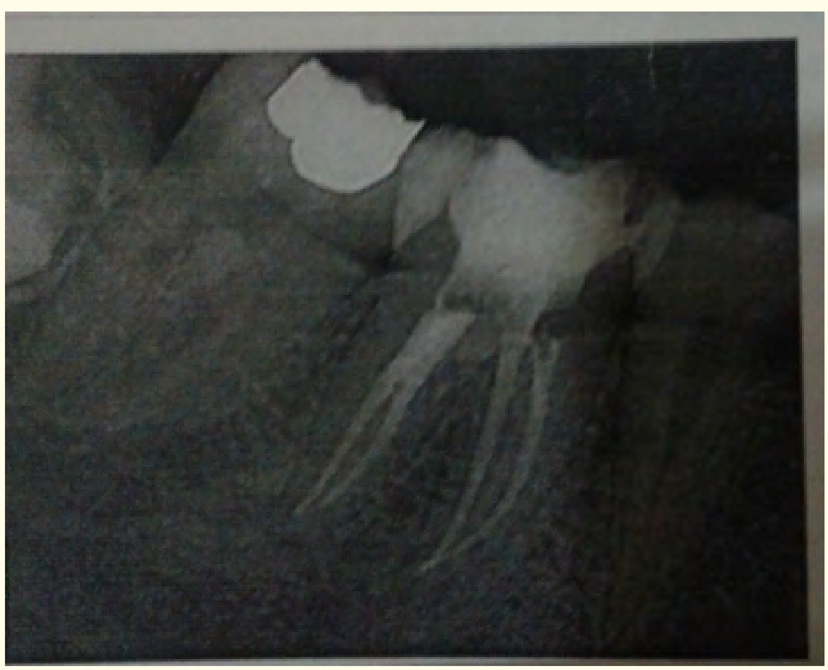

Figure 5: *Root canal obturated radiograph.*

The Endotec II: (Medidenta International Inc). It is a battery powered heat controlled spreader/plugger. The quick change heated tips are sized equivalent to a No 30 instrument which are autoclavable and can be adjusted to any access angulation. It has been demonstrated that the Endotec produced a fusion of the gutta-percha in to a solid homogenous mass. This device's technique requires cleaning and shaping of canals with a continuous taper design and an apical stop.

The continuous wave compaction technique: It is a variation of warm vertical compaction. It employs the System B unit and tapered stainless steel pluggers- each with a tip diameter of 0.5 mm. The system B unit is set to 200oC in touch mode. The plugger is inserted in to the canal orifice and activated to remove the excess coronal material. Compaction is initiated by placing the cold plugger against the gutta-percha in the canal orifice. Filling the remaining space left by the plugger can be accomplished with a thermoplastic injection technique or by fitting an accessory cone in to the space with sealer, heating it and compacting it with vertical pressure.

The Down Pak- 3D Obturation with heat and vibration: The Down Pak is an innovative device recently introduced and this allows three dimensional obturation with heat and vibration. The Down Pak is cordless and designed with a multifunctional, endodontic heating and vibrating spreader device and can be used for both warm vertical and lateral condensation techniques. It is suitable for use with Gutta-percha, Resilon, and current Hybrid resin filing materials. It is versatile device. Down Pak offers a wide selection of tips in nickel titanium and ultrasoft stainless steel. The heat carrying instruments are consistent with tapered root canal preparations. The system also offers two tips for cautery or removal of plastic obturator handles.

Vibration has been shown to increase gutta-percha fill density. Studies have shown that Down Pak's combination of heat and vibration resulted in a denser more compact filling of the root canal space. It is claimed that the system works with all warm condensation techniques and may even benefit cold lateral techniques when using the only vibration feature.

Figure 6: *The Down Pak device.*

Plastic- injection techniques: The Obtura II system consists of a hand held gun with a chamber in to which pellets of gutta-percha are loaded, along with silver needles of varying gauges used to deliver the thermoplasticized material to the canal. The temperature and thus the viscosity of the gutta-percha can be adjusted. A hybrid technique is often employed by filling the canal to approximately 4 to 5 mm from the apex using the lateral compaction technique before gradually filling the coronal portion with thermo plasticized gutta-percha.

The Calamus Flow Obturation Delivery System: (Dentsply-Tulsa Dental. Tulsa, OK)

Has a handpiece and activation cuff to enable control of the flow and temperature of the gutta-percha in to the canal. The activation cuff is released to stop the flow. The gutta-percha is packed in disposable, single use cartridges, and a filling material indicator lets you monitor the amount of remaining filling material. The choice of gutta-percha cannula depends on the desired consistency and whether or not the gutta-percha will be condensed. The temperature of the thermoplasticized gutta-percha as it is extruded through the needle tip ranges from 38°C to 44°C. The gutta-percha remains able to flow for 45 to 60 seconds, depending on the viscosity.

Gutta Flow: It is cold, flowable technique that combines polydimethylsiloxane sealer, powdered gutta-percha with a particle size of less than 30 micron meters and nano silver particles contained in a plastic capsule that is triturated prior to use. The apical preparation should be as small as possible to prevent extrusion, and the canal filled combined with a master point of gutta-percha. The viscosity diminishes under pressure, enabling flow in to the smallest canals. Gutta flow can be directly applied in to the canal with a file or coated on to the master point.

The Elements Obturation Unit (Sybron Endo): It contains a system B devices and a gutta-percha extruder in a motorized handpiece. The extruder tips are sized 20, 23, and 25 gauge and are pre bent. The disposable cartridges of gutta-percha are heated quickly and the units shut off automatically to prevent overheating of the material.

The Ultrafill 3D System (Hygienic- Coltene- Whaledent): It is low heat (70o) system with steralizable injection syringe, three different types of disposable gutta-percha cannulae with attached needles that can be precurved and a portable heating unit.

It sets regardless of moisture or temperature and has very low solubility. The material expands slightly (0.2%) resulting in an excellent seal of the root canal. Guttaflow with a single gutta-percha master cone creates an apical seal that is equivalent to the seal produced with gutta-percha /AH Plus sealer, using warm vertical compaction. Guttaflow should not be used with deciduous teeth as it is not resorbed.

Regardless of the technique any plastic injection system has the potential for significant overfilling of the canal and the clinician needs to be attentive to control the canal obturating material.

Carrier Based Gutta-Percha:

1) Thermafil (Dentsply-Tulsa Dental): Consists of a plastic core coated with alpha phase gutta-percha and a heating device that controls the temperature. The carrier is set to predetermined length and after heating it the clinician has approximately 10 seconds to retrieve and insert it in to the canal, without rotating and twisting it. The position of the carrier is verified radiographically. The gutta-percha is allowed 2 to 4 minutes to cool before resecting the carrier. An advantage to this technique is the movement of gutta-percha in to lateral and accessory canals, however extrusion of materials beyond the apical extent of the preparation is a disadvantage.

2) Successfil (Hygienic-Coltene-Whaledent): This system uses gutta-percha in a syringe. Carriers (Titanium or Radiopaque plastic) are inserted in to the syringe to a measured length of the canal. The gutta-percha is expressed on the carrier, with the amount and shape determined by the rate of withdrawal from the syringe. The carrier with the gutta-percha is placed in the canal to the prepared length. The guttaperchs can be compacted around the carrier with various pluggers, depending on canal morphology. This is followed by the serving of the carrier slightly above the orifice using a bur.

3) SimpliFill (Discus Dental, Culver City, CA): It is employed fallowing canal preparation using Lightspeed instruments. The carrier has an apical plug attached with 5 mm of gutta-percha, which can be modified if the plug is too small by clipping the end in 1 mm increments to obtain an appropriate fit. A carrier consistent with the master apical rotary file is attached to within 1 to 3 mm of the prepared length. The carrier is slowly advanced to the prepared length which may require firm pressure. With the plug at the corrected working length, the handle is quickly rotated counter clockwise, a minimum of four complete turns. The coronal space can then be filled with gutta-percha. This sectional technique is efficient.

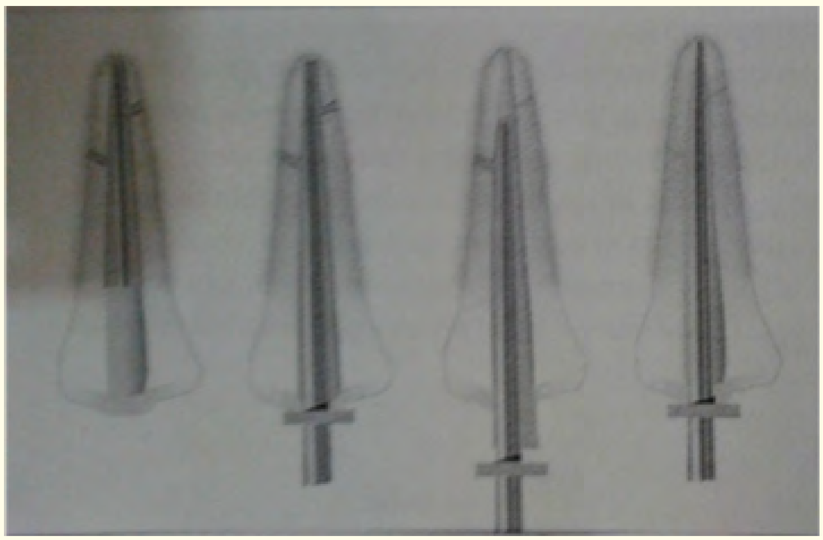

Figure 7: *Carrier based obturation with SimpliFill.*

4) Thermomechanical Compaction: This method utilizes a compactor with flutes similar to a Hedstrom file, but with the flutes reversed. The compaction is selected based on the size of the canal preparation and inserted with tha hand piece activated alongside the gutta-percha cone 3 to 4 mm from the prepared length. The gutta-percha is heated by the friction of the rotating bur, and is compacted apically and laterally as the device is slowly withdrawn from the canal.

The main advantages include simplicity, speed, and the ability to fill canal irregularities. Disadvantages are extrusion of filling material beyond the apex, the potential for instrument fracture, difficulty in using the technique in curved canals, and uncontrolled heat generation.

Single Cone Technique: The Active GP™ precision obturtation system utilizes Glass ionomer technology, extending the working time of the Glass ionomer sealer by modifying its particle size to the nanoparticle level. The gutta-percha cones are coated with Glass ionomer particles at a thickness of 2 micron meters. The cones can be bent up to 180^0 without showing any signs or symptoms of delamination of the coating, and are matched in size to the preparations created by the files. Matching of the primary cone to the preparation is very important with any single cone technique, because the accurate fit of the cone to the preparation minimizes the amount of sealer used, as well as minimizing any potential shrinkage.

Conclusion

The dental profession's most important goal is to maintain the health and integrity of patient's dentitions. Dental clinicians must recognize that a particular method of obturation will not satisfy every single case that requires endodontic therapy. The obturation method selected whether a traditional method or a more contemporary one, must be consistent with the principles of clinical practice, that is to provide the best treatment for patients. A seal of the root canal system is desirable but contemporary material and methods available for obturation, do not always achieve this physical and biological goal. The advent of new devices and techniques such as those that utilize heat and vibration for warm lateral and warm vertical condensation are revolutionizing the practice of endodontics and making obturation procedures more predictable.

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