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Obturation of the Root Canal System

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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, and obturation. Once cleaning and shaping is complete the clinician must obturate the canal. There are many different materials and techniques available each with their own discrete advantages and disadvantages. Whichever technique is used, the goal is to seal the entire prepared length of the root canal. 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, Gutta Percha, Dentin, Smearlayer, Heat

Introduction

The ultimate biologic aim of the root canal treatment is the prevention or cure of apical periodontitis. When the pulp is rendered non–viable, root canal treatment attempts to fulfil its aim by debridement, disinfection and obturation of the root canal system[1]. The role of microorganisms and their by-products has been demonstrated countless times as the main causative factor in the aetiology of apical periodontitis, therefore elimination of microorganisms and their by-products is the key to success [2]. Adequate access and a straight-line path to the canal system allow complete irrigation, shaping, cleaning, and total obturation of the root canal system[3]. Prior to obturation removal of the smear layer may enhance the ability of intracanal medicament or root canal sealer to enter dentinal tubules.[4] The obturation stage is carried out to fill the root canal to provide a hermetic seal from the

coronal orifice of the canal to the apical foramen at the cemento-dentinal junction[5]. No matter how well we seal the root canal, if the coronal end is not adequately sealed, "crown-down bacterial leakage" will occur in no time therefore, coronal seal forms an integral part of endodontic treatment and therefore plays a vital role in the treatment's success[6].

Rationale of obturation

The goals for consistently successful endodontic treatment is the total obliteration of the canal space and perfect sealing of the apical foramen at the dentin-cementum junction and accessory canals at locations other than the root apex with an inert, dimensionally stable, and biologically compatible material. The establishment of a well obturated system would serve three main functions:

1. Prevent periodontal or periapical fluids percolating into the root canals and feeding microorganisms. (An incompletely filled canal allows percolation of tissue exudate into the unfilled portion of the root canal)
2. Prevent coronal leakage of microorganisms or potential nutrients to support their growth into the dead space of the root canal system.
3. Entomb any residual microorganisms that have survived the debridement and disinfection stages of root canal treatment, in order to prevent their proliferation and pathogenicity[1,7].

Ideal properties of obturation

Many materials and techniques are available to obturate the root canal system but no single material can currently satisfy all the requirements.

According to Grossman the properties of an ideal obturation material are:

Easily introduced into the root canal system and seal the canal laterally as well as Apically.

Should not shrink after being inserted, bacteriostatic, radio-opaque.

Should not stain tooth structure and not irritate periapical tissue.

Should be sterile or easily and quickly sterilized immediately before insertion and should be able to remove easily from the canal if necessary.[8]

Sealers

when filling root canals with a solid core material, some form of cement is required for a fluid tight seal that fills the minor gaps between the core material and the dentinal wall of the canal to prevent leakage thus Sealers are a necessary part of the obturation process [9]. According to Orstavik, sealers play an important role in sealing the root canal system with entombment of remaining microorganisms and it also fills inaccessible areas of prepared canals.[10]

Root canal obturating materials

Silver cones was introduced by Jasper in 1941[11]. Silver points were historically indicated and well accepted root canal obturation material; but modern techniques and improved materials provide the clinician with much better options. Silver points lack plasticity, their inability to fill the irregularly shaped root canal system permitted leakage and makes them less favorable as filling materials. Silver points were found to corrode spontaneously in the presence of serum and blood, and the Corrosion byproducts can also cause irreversible staining of the tooth structure and surrounding tissues [12,13].

Gutta-percha was firstly introduced as a restorative material and later developed into an endodontic filling material. Various forms of gutta-percha are available for usage and the current forms are solid core gutta-percha points, standardized, non- standardized, thermo plasticized gutta- percha, thermo mechanical compactible gutta-percha, injectable form, solid core system, and medicated gutta-percha.[14] GP is a trans-isomer of polyisoprene available in two forms alpha and beta. Alpha form occurs

in the tree, which is the natural form and most of the commercially available products are in the beta form.[15] Gutta-percha points can be sterilized by placing the cones in 5.25% NaOcl for 1 minute[16].

Resilon is a thermoplastic synthetic polymer based root canal filling material. Based on polymers of polyester, Resilon contains bioactive glass and radiopaque fillers. It resembles gutta percha, has the same handling properties. For retreatment purposes it can be softened with heat, or dissolved with solvents like chloroform.[17]

Hydroxyapatite, Calcium Hydroxide, MTA, Biodentine is used to induce calcific barrier in canals with open apex to permit obturation. Placement of apical plug is crucial for sealing and preventing bacterial leakage.[18]

Obturation Techniques

Different techniques were proposed for the obturation of the root canal system. The choice of the obturation technique depends on the canal anatomy and the unique objectives of treatment in each case. Different obturation techniques include Lateral condensation and warm vertical condensation of gutta-percha, continuous wave compaction technique, Down Pak- 3D Obturation with heat and vibration, Plastic- injection techniques, Calamus Flow Obturation Delivery System , Gutta Flow, The Elements Obturation Unit, Ultrafill 3D System, Carrier Based Gutta-Percha, Single Cone Technique.[19,20]

Lateral compaction of gutta-percha

It is a successful obturation technique due to its simplicity, not requiring specific and expensive instruments and its low cost. The objective of this technique is to fill the canal with gutta-percha points by compacting them laterally against the sides of the canal walls. A master cone corresponding to the final working length and canal shape is chosen, coated in sealer and compacted laterally with finger spreaders. Accessory cones will be used to complete the obturation. Disadvantages of this technique include inadequate adaptation of root filling material to the root canal walls, risk of void formation and partial filling in certain hard-to-reach areas of the root canal system. [14,21]

Use of vibration, heat and ultrasonics : More recently, a combination of vibration and heat using the Down Pak obturation device an arternative to cold lateral compaction with finger spreaders are used. Ultrasonic condensation technique produced adequate obturation and clinical success rate.

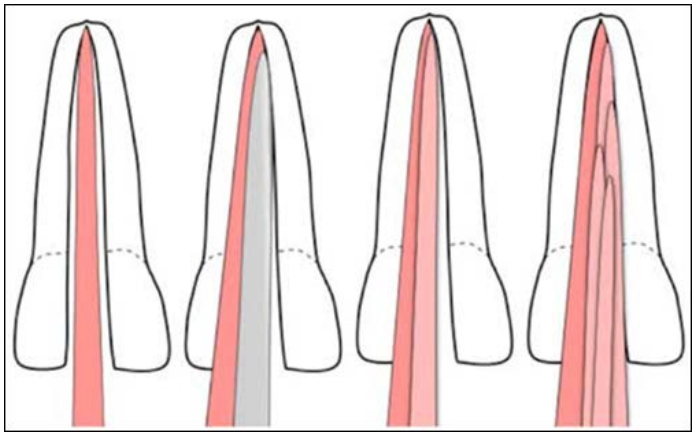

Figure 1: Cold lateral condensation following placement of master cone

Warm Vertical Condensation Of Gutta-Percha

Vertical condensation of gutta-percha forms the basis for many techniques, such as the warm gutta-percha, master cone sectional, and thermoplasticized techniques. A master cone is fitted corresponding to the correct working length and canal size with resistance to displacement. Once confirmed, the cone is coated with sealer and placed in the canal, 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 3−4 mm segment of the canal is filled. The canal system is then backfilled 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.

Temperature control : Commercial heating device, such as Down Pak cordless obturation device, System B' or 'Elements and Touch "n" Heat alternatives to applying heat with a flame heated instrument because they permit temperature control. Heat at the root surface greater than 10^0C produce irreversible bone damage.[21]

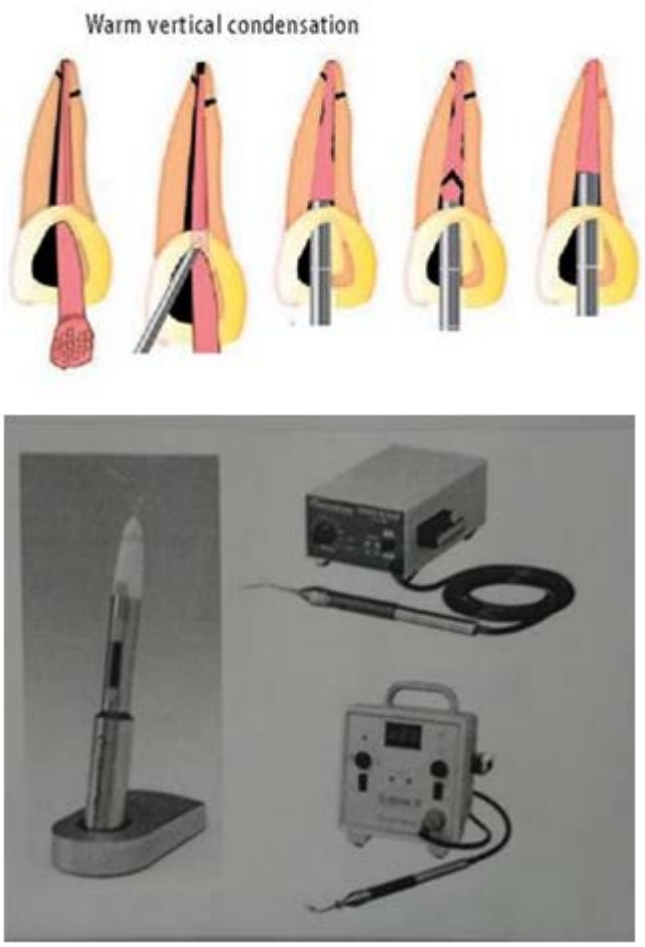

Figure 2: Temperature control devices.

The Endotec II : Considering the ease and speed of lateral compaction as well as the superior density gained by vertical compaction of warm gutta-percha, Martin developed a device Called EndoTec II that appears to achieve the best qualities of both techniques.

Continuous Wave Compaction Technique

It is a method of root canal filling with thermoplasticized gutta percha using tapered pluggers to pack the heat-softened gutta-percha into the root canal system. The tip of the master gutta percha cone was coated with sealer and placed in the canal. The system B unit is set to 200°C in touch mode. Plugger is inserted in to the canal orifice and activated to remove the excess coronal material. After removing the coronal and middle portions of the fillings, packing was followed by injecting gutta percha in 3-mm increments into the canal, a cordless gutta percha obturation gun is used for back filling.[22]

Down Pak- 3D Obturation with heat and vibration

The advent of cordless devices like the DownPak makes it easier for the clinician to provide a 3D obturation more effectively. The use of the DownPak is similar to a combined vertical and lateral compaction of gutta-percha. Down Pak offers a wide selection of tips in ultrasoft stainless steel and nickel titanium.. The heat carrying instruments are consistent with tapered root canal preparationsand it also offers two tips for cautery or removal of plastic obturator handles[23].

Figure 3: Down pak

Plastic- injection techniques

Obtura has helped to improve the density of fills as well as increase efficiency. Obtura III 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. 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[24].

The Calamus Flow Obturation Delivery System

The Calamus Flow handpiece is used with a one-piece gutta percha cartridge and integrated cannula to dispense warm gutta-percha. It 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[25].

Gutta flow: It is a novel filling system for root canals that combines two products in one; sealer and gutta-percha in powder form with a particle size of less than 30µm.

The Elements Obturation Unit: The Elements Obturation Unit combines System B technology with a motor-driven extruder handpiece to make obturation efficient, predictable, and accurate. From downpack to backfill, the Elements Obturation Unit puts the Continuous Wave of Condensation Technique into one simple-to-operate device that takes up only 1/3 the space of 2 separate machines.

The Ultrafill 3D System: It is low heat 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.

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

Thermafil : Thermafil is a patented endodontic obturator consisting of a flexible central carrier that is uniformly coated with a layer of refined and tested “alpha phase” gutta-percha. When heated, the “alpha phase” gutta-percha becomes sticky and tacky, with excellent flow characteristics and obturates the canal and available lateral and accessory canals.

Successfil: SuccessFil System Cores are biocompatible for obturating the root canal. Made of implant-grade titanium (Ti 6AL 4V) alloy, they have non-cutting tips and are highly flexible for use in curved as well as straight canals. Carrier with the gutta-percha is placed in the canal to the prepared length and guttapercha 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.

SimpliFill: SimpliFill consists of standardised, approximately 4mm-long gutta-percha tips in standard ISO sizes mounted on a carrier. Following a try-in, the appropriate gutta-percha tip is inserted slowly into the canal without rotating. After apical placement, it is separated from the carrier by four full twists in an anti-clockwise direction. This allows for fast and safe sealing of the apical canal section in an easy manner.

Thermomechanical Compaction: This method utilizes a compactor with flutes similar to a Hedstrom file, but with reversed flutes. Based on the size of the canal preparation compaction is selected and inserted with the hand piece activated alongside the gutta-percha cone 3 to 4 mm from the prepared length. 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[19].

Single Cone Technique

This refers to the use of a size-matched greater taper cone to fit the preparation of the canal precisely, Such an approach is often used in conjunction with specific filing systems. This technique is often reliant upon sealer and may not adequately obturate the canal in 3 dimensions.

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, aswell as minimizing any potential shrinkage[21].

Conclusion

There is minimal evidence to support the use of one method of obturation over another. All techniques have their own advantages and disadvantages. 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. Having a broad knowledge Of the options helps the clinician choose the Optimal technique for the tooth being treated. The advancement in 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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