Original Article

Dentinal Adaptation of Warm Thermoplastic Obturating Material and Cold Thermoplastic Obturating Material: An *In vitro* Study

Abstract

Introduction: The objective of endodontic obturation is to provide a complete seal along the length of the root canal system, thereby ensuring the healing and sustained health of the periradicular tissue. Root canal obturation involves the three-dimensional filling of the entire root canal system and is a critical step in endodontic therapy. Gutta-percha has universally been accepted as the gold standard for root canal filling materials. However, it lacks bonding to the internal tooth structure resulting in the absence of complete seal. **Aim:** The aim of the present study is to compare the dentinal adaptation of warm thermoplastic obturating material and cold thermoplastic obturating materials. **Materials and Methods:** Thirty single-rooted, anterior noncarious human teeth extracted for periodontal or orthodontic reasons were used for the study. The samples were stored in distilled water until obturation. The specimens were then randomly divided into three groups of ten specimens each: Control group – Cold lateral condensation with AH Plus, Group I – Endosure with AH Plus®, and Group II – GuttaFlow® 2 with master cone. The obturation for each group was done following manufacturer's instructions. Under On-demand software, the area of voids at the level of 3 mm, 5 mm, and 8 mm from the apex was observed for all the samples. The obtained results were submitted for statistical analysis. **Results:** The result in the present study showed that Endosure provides a better consistent seal as compared to cold lateral condensation, or GuttaFlow 2 techniques. **Conclusion:** Mean void value was maximum for GuttaFlow 2 group, followed by cold lateral condensation, Endosure. Though there was a difference in the mean void values, it was not statistically significant except between Endosure and GuttaFlow 2. The result in the present study showed that Endosure provides a better seal as compared to cold lateral compaction, GuttaFlow 2 or Endosure technique.

Keywords: *Cone beam computed tomography, Endosure, GuttaFlow 2, obturation*

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Introduction

The key to a successful root canal treatment is proper diagnosis and treatment planning. Knowledge of canal anatomy and morphology, canal debridement, and sterilization of canal and obturation play important role in the success of a root canal treatment. Root canal obturation is defined as "the three-dimensional filling of the entire root canal system as close to the cementodentinal junction as possible." Minimal amounts of root canal sealers are biologically compatible and are used in conjunction with the core filling material to establish an appropriate seal.[1] Earlier studies stated that apical seal was of prime concern; however, newer studies state that coronal seal also has equal importance in maintaining root canal disinfection for an endodontically treated teeth.[1] The vital step in root canal treatment is three-dimensional filling of root canal system by obturating material.[2] Gutta-percha is considered as gold standard material for obturation.[1] However, due to its inability to bond to the canal walls, various modifications have been made in its composition and the techniques of using it for obturating prepared canals.[3] Lateral condensation of gutta-percha is the most widely accepted technique for obturating canals, but studies have proved that it does not provide appropriate seal throughout the root canal system.[1] It was hypothesized that if a dental material could be developed that would bond to root canal system, and not only provide the good seal throughout the canal but also reinforce the endodontically treated teeth.[3] After development of the warm thermoplastic technique, various developments were

How to cite this article: Raghuwanshi S, Jain P, Patni PM, Pandey SH, Hiremath H, Baghel S. Dentinal adaptation of warm thermoplastic obturating material and cold thermoplastic obturating material: An *In vitro* study. Contemp Clin Dent 2019;10:64-8.

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Access this article online

Website: www.contempclindent.org

DOI: 10.4103/ccd.ccd_312_18

Quick Response Code:

done for evolution of an accurate and cheaper technique to obturate the canal.[2] This led to the development of cold thermoplastic obturating material which did not require any additional machine or setup and was not technique sensitive.[3] GuttaFlow® 2 (Coltene Whaledent, Switzerland) is the cold thermoplastic obturating paste which is made by the combination of polydimethylsiloxane with fine gutta-percha powder.[1] It is the sealer and gutta-percha powder combination which is flowable at room temperature and does not require any system to obturate root canal.[1] Warm thermoplastic obturation technique contains Beta Obturation Gun (B and L Biotech, Italy) device integrating a central carrier coated with alpha-phase Sure-Endo gutta-percha. Gutta-percha on heating adheres to the carrier as it becomes thermoplasticized.[4] Carrier transports gutta-percha when inserted into prepared root canals and is a part of obturation. This technique shortens the obturation time and alpha phase gutta-percha replicates the canal wall well. However, disadvantages such as chances of overfilling, shrinkage after cooling of gutta-percha, stripping of gutta-percha from carrier after cooling resulting in apical area of canal filled with carrier as obturating material.[4] Herein, we compare the efficacy of GuttaFlow 2 and Beta Obturation Gun with alpha-phase Sure-Endo gutta-percha for dentinal adaptation following obturation. In this study, we compared the efficacy of warm thermoplastic obturation, alpha phase (Endosure gutta-percha) and cold obturating material (GuttaFlow 2) for obturating the root canal system.

Objectives

The objectives of this study are to compare the dentinal adaptation of warm thermoplastic obturation, and cold thermoplastic obturation. In this study, we evaluate the dentinal adaptation of three different obturating material and techniques including warm thermoplastic material Endosure gutta-percha, lateral condensation with 2% gutta-percha and cold thermoplastic obturating material GuttaFlow 2.

Materials and Methods

Thirty single-rooted noncariously decayed teeth that were indicated for periodontal or orthodontic extraction, teeth were chosen for the study. All the teeth were checked and examined under dental operating microscope for any defect or deformity in the tooth structure. The exclusion criteria included: immature root apices, cracks, root caries, fracture and resorption and carious defects. All the single-rooted teeth were preexamined on a radiograph using radiovisiography for the presence of an extracanal. Only those teeth which had a single canal were included in the study. All the teeth were taken and stored in a sterile physiological sterile water solution at room temperature for 24 h. The selected teeth were sectioned from the cervical region using a stainless steel diamond disc of size 0.05 diameter. Ultrasonic cleaning of all the teeth was done meticulously and again checked for any external deformity in selected teeth. Decoronation of all the sampled teeth was done to maintain a standard root length of 14 mm [Figure 1]. All the samples were submitted for root canal instrumentation and biomechanical preparation (BMP).

Using ISO #15 K file, canals were measured until the tip of file reached the apical foramen. Working length (WL) is determined 1 mm short of the apex. Instrumentation was performed to the ISO size 35 by stepback technique followed by irrigation with 5.25% NaOCl and 17% EDTA alternatively. Storage of all the samples was done in distilled water until obturation. All the samples were divided into three groups: Group 1: Control group-Cold lateral condensation; Group 2: Endosure gutta-percha obturation with AH plus sealer; Group 3: GuttaFlow 2 with mastercone.

For the control group, hand spreader was selected and then paper point was used to liberally coat the walls of the canal with AH plus sealer. #35K master gutta-percha cone (taper 0.02) was placed to the WL and a stainless steel ISO standardized No. 25 finger spreader was applied under vertical load. Compaction and accessory cone insertion was continued until the spreader reached no further than 2–3 mm into the canal.

For Group 1, 35/0.02 tapered gutta-percha cone was inserted to the WL and examined for tug-back. The sealer was applied to the canal walls using a #35 k-file. Master gutta-percha cone tip was coated with sealer and placed in the canal. A heating device was used to down pack and adapt the gutta-percha to canal. The remaining coronal space was then filled backfill system.

For group 2, Master Cone gutta-percha was fitted up to the WL and tug back was ensured. GuttaFlow 2 sealer was placed into the canal. The apical part of master gutta-percha cone was coated with sealer and placed. The master cone was condensed laterally by finger spreader. The space created was filled with auxiliary gutta-percha point. The procedure was repeated until gutta-percha point could not be introduced more than 3 mm into the root canal.

After obturation of all the groups, the samples were incubated for 48 h at 37°C and 100% humidity to permit the sealer to set. Two days later, each and every one of sample were submitted for cone beam computed tomography (CBCT) examination [Figure 2].

A complete CBCT scan was done with the samples. One calibrated specialist, dental radiologist, and endodontist analyzed the CBCT images and calculated the area of voids using On Demand software (Kodak Carestream, Rochester, NY, USA). Under On-demand software, the number and area of voids present in the obturation done by three different methods were evaluated for all the samples at coronal [Figure 3], middle [Figure 4], and apical [Figure 5] third of root.

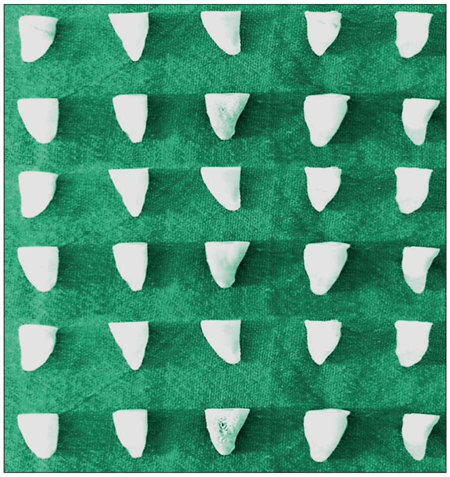

Figure 1: All the decoronated samples selected for the study. Samples are decoronated at a standard length of 14 mm

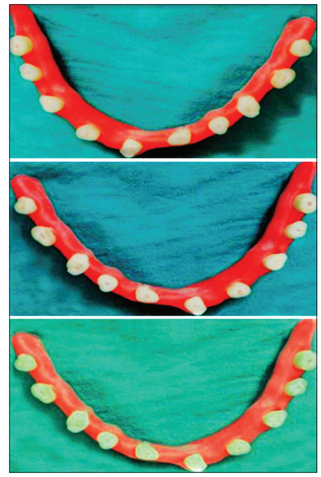

Figure 2: All three group samples submitted for the cone beam computed tomography examination one by one

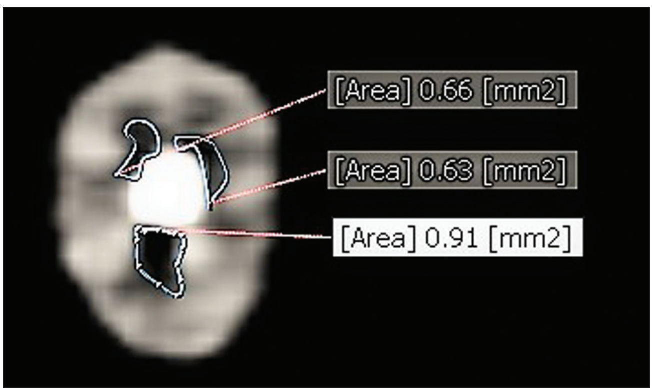

Figure 3: Cone beam computed tomography image shows the area calculated at coronal third by On-Demand software in cone beam computed tomography (Kodak Carestream 9000 3D)

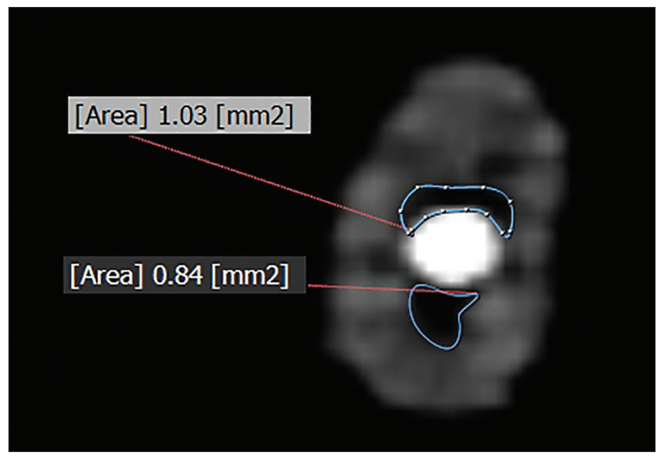

Figure 4: Cone beam computed tomography image shows the area calculated at middle third

Number and area voids were calculated at the level of 3, 5, and 8 mm from the apex. Mean value of area of voids at 3, 5, and 8 mm calculated. The obtained results were submitted for statistical analysis.

Statistical analysis

Statistical analysis was done by ANOVA and Shapiro–Wilk test on the basis of obtained data. The mean table for the area of voids calculated in three different groups and three different levels of 3, 5, and 8 mm from the apex. The results in present study showed that Endosure gutta-percha provides a better consistency when compared to cold lateral condensation, of GuttaFlow 2 technique [Table 1].

Results

The results showed that the dentinal adaptation of warm thermoplastic (Endosure gutta-percha) obturating material provide better adaptation than the cold lateral condensation obturating technique and cold thermoplastic obturating (GuttaFlow 2) technique. Less number of voids and area were calculated by using On-Demand software in Endosure gutta-percha (warm thermoplastic obturation) than the cold lateral condensation and cold thermoplastic obturating GuttaFlow 2. The number and area of voids were calculated and the scores were given accordingly by the examiners to maintain uniformity of the study.

All the obturating techniques are sensitive according to usage, this study showed a better dentinal adaptation ability of warm thermoplastic obturation Endosure than cold lateral condensation and cold thermoplastic oburation material GuttaFlow 2.

Discussion

BMP in adjunct with chemical methods aims to make root canal devoid of microorganisms but sometimes, they remain active in dentinal tubules even after potent preparation. To overcome the issue of remaining microorganisms and their endotoxins perfect apical and coronal seal are prudent. The main causative factors for pulpal disintegration and periradicular pathology are microbial irritants and their products of pulp degeneration. Thus, proper seal of root canal is required including chemo mechanical preparation

Table 1: The mean area of voids calculated at three different level from the apex of teeth selected for the study with three different obturating techniques

	Thermoplastic obturating with Endosure gutta-percha (mm^2)	Cold thermoplastic obturating with GuttaFlow 2 gutta-percha (mm^2)	Conventional obturation with 2% gutta-percha points (mm^2)
Coronal 3rd (8 mm from apex)	0.447	0.618	0.512
Middle 3rd (5 mm from apex)	0.611	0.784	0.644
Apical 3rd (3 mm from apex)	0.351	0.588	0.421

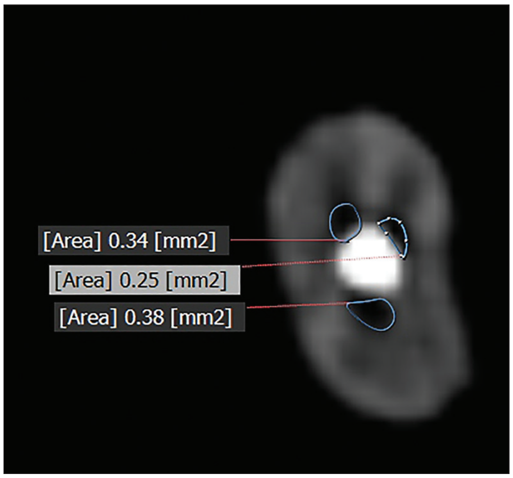

Figure 5: Cone beam computed tomography image shows the area calculated at apical third

cleaning and shaping followed by obturation technique.[2] Various materials had developed by different researchers for perfect obturation. However, gutta-percha, not only being as ideal filling material, is the most widely accepted solid core obturation material as it satisfies majority of Grossman's criteria. Gutta-percha has its own disadvantages such as lack of flexibility and adaptability, ease of displacement under pressure, but are overpowered by its advantages.[5]

The most common method of obturating root canal is lateral condensation and is widely used as a control group for evaluation of newer obturation techniques. Advantages of lateral condensation include preventability, simplicity to use, conventional preparation, and inhibited position of materials.[6] However, this method has disadvantages like be short of homogeneity of material, enhance quantity of voids, less adjustment to canal walls and irregularities.

GuttaFlow 2, which is modified gutta-percha, contains powder of gutta-percha particles, having particles of <30 μm diameter and polydimethylsiloxane as a sealer. This material provides improved seal and good adaptability due to increased flowability and its slight expansion (0.2%) on setting, which enhances its adaptation to root dentin walls. No additional machine or setup is required for implicating in the canals. The another material used is Endosure gutta-percha with an integrating a central carrier coated with a-phase gutta-percha. Gutta-percha on heating adheres to the carrier as it becomes thermo plasticized. Carrier transports gutta-percha when inserted into prepared root canals and is a part of obturation. This technique shortens the obturation time and alpha phase gutta-percha replicates the canal wall well. However, disadvantages like chances of overfilling, shrinkage after cooling of gutta-percha, stripping of gutta-percha from carrier after cooling resulting in apical area of canal filled with carrier as obturating material.[7]

In this study, we compared the efficacy of warm (Endosure gutta-percha) and cold obturating material (GuttaFlow 2) for obturating the root canal system. Firstly, after the conventional obturation techniques, the thermoplastic obturating material is developed which will fill the entire canal completely. Thermoplastic gutta-percha was developed so as to overcome the drawbacks of previous obturating techniques. In this technique, the gutta-percha comes in the form of bullets instead of point form. This will be incorporated into the canal by specific gun OR machine with point heat that will directly incorporate the gutta-percha into the canal while avoiding the gaps and voids in the canal. Endosure is one of the thermoplastic technique of filling the root canal.[5]

Voids in different obturation techniques and material are the most compelling cause for failure of endodontic treatment. According to Ingle 58% of endodontic treatment failed due to incomplete obturation. To poise the experimental group in this study, in terms of canal anatomy single rooted teeth with single patent root canals were selected.[7]

To have more uniform preparation for most canals, canal diameter was standardized to ISO size 35 at apical constriction. To simplify instrumentation and obturation, teeth were decoronated from the apex at about 14 mm using water cooled diamond disc. The area and number of voids calculated by CBCT analysis at a standardized level of 3, 5 and 8 mm from the apex. Our results showed that warm thermoplastic obturating material (Endosure gutta-percha) showed good results by less number and area of voids present in obturation.[4] Cold obturating material GuttaFlow 2 showed more number and area of voids in obturation.[3,5] In harmony with other studies GuttaFlow 2 exhibited maximum apical leakage. Possible reasons for this property of GuttaFlow 2 may be due to poor wettability of dentin, lack of leakage free seal between particles and sealers and lack of chemical binding between gutta-percha particles and sealers.[4] Result of present study showed that warm thermoplastic obturating material Endosure gutta-percha provides more stable seal as compared to cold lateral condensation or cold thermoplastic obturating material GuttaFlow 2. Moreover, for evaluating sealing abilities of GuttaFlow 2, further studies are required.

Conclusion

Within the limitations of this study following conclusions were drawn. All three groups showed voids and none of the methods were able to achieve adequate seal. Mean voids value was maximum for GuttaFlow 2 group, followed by Cold lateral condensation, Endosure gutta-percha. Though there was a difference in the mean void values, it was not statistically significant except between Endosure gutta-percha and GuttaFlow 2. The result in the present study showed that Endosure provides a better seal as compared to cold lateral compaction, GuttaFlow 2.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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