# An Evaluation of Gutta-Percha Penetration Depth into Simulated Lateral Canals by Using Three Different Obturation Techniques (A Comparative Study)

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## ABSTRACT

Background:sThe aims of this study were to evaluate and compare the ability of three different techniques to obdurate simulated lateral canals, evaluate the effect of the main canal curvature on obturation of lateral canals and compare the gutta-percha penetration between coronal and apical lateral canals.

Materials and methods: Resin blocks with 30 straight and 30 curved were used in this study. Each canal has two parallel lateral canals. The main canal has 0.3 mm apical diameter and 0.04 taper. The canals were divided into six groups according to canal curvature and obturation techniques used (n=10): Groups C1 and C2: straight and curved canals obturated with continuous wave technique using E&Q masterTM system. Groups O1 and O2: straight and curved canals obturated with Obtura II. Groups T1 and T2: straight and curved canals obturated with Thermafil obturators. Soapy water was used to simulate sealer in all obturations performed. The depth of gutta-percha penetration into lateral canals was measured using computerized stereomicroscope.

Results: There were very highly significant differences between the obturation techniques at each lateral canal level in both straight and curved canals. Continuous wave using E&Q masterTM system exhibited the greatest gutta-percha penetration into lateral canals with very highly significant difference from both other techniques at majority of lateral canals. There was non- significant difference between Thermafil and Obtura II except at coronal lateral canal of straight main canals where the difference was very highly significant.

The gutta-percha depth was greater in coronal than apical lateral canals in all groups of both straight and curved canals, and gutta-percha depth was greater in straight than in curved canals within each obturation technique.

Conclusion: This study showed that all the three obturation techniques used were able to obturate simulated lateral canals with the continuous wave technique being the best. Gutta-percha depth was less in the apical than the coronal lateral canals. Canal curvature can influence the gutta-percha depth.

Key words: Obturation, lateral canal, Thermafil. (J Bagh Coll Dentistry 2016; 28(2):1-6).

## INTRODUCTION

Lateral canals are difficult to instrument and to irrigate during endodontic therapy and may allow bacterial growth. Persisting bacteria in teeth endodontically treated may be located in uninstrumented areas like lateral canals [(1)]. These lateral canals can establish connection between the main root canal and periodontal ligament, as well as the apical foramen [(2)]. So that, the three-dimensional obturation of the root canal system becomes extremely important, as it could prevent re-infection and isolate microorganisms in inaccessible areas, without access to space and nutrients [(1)].

Gutta-percha in combination with a root canal sealer is the most commonly used filling material. The sealer fills the minor irregularities and acts as a lute between the gutta-percha and canal wall. Some sealers shrink upon setting, whilst others are susceptible to decomposition [(3)]. The amount of sealer should be restricted to a thin layer between the gutta-percha and the walls of the canal [(4)], but it should be sufficient to restrict the passage of microorganisms and their by-products that are responsible for periradicular disease [(5)].

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Vertical compaction of warm gutta-percha can produce a three- dimensional obturation of the root canal space and, with extraordinary frequency, also results in the filling of lateral of lateral canals and better outcomes in treatments using warm gutta- percha [(3)]. The curvature of the main canal has an influencing effect on the quality of obturation. When the curvature of the main canals reaches about 25°, it can greatly reduce the ability of some obturation techniques to obturate lateral canals; however other techniques may be reduced to lesser extent or even not affected [(6)].

Because of the introduction of the vertical compaction of warm gutta-percha, many thermoplasticized procedures, and devices have been used to improve the three-dimensional sealing of the root canal space [(7)]. Previous studies, comparing the effectiveness of filling techniques, have given conflicting results. Some reported that none of the techniques studied provided a superior seal whilst other studies reported better filling [(8)].

## MATERIALS AND METHODS

### Sample Preparation

Eight Thermafil training blocks each with four simulated main canals were selected. Two parallel lateral canals, with nominal diameter of 0.5 mm, branched from each main canal, at right angles from the main canal axis. The most apical canal at 5 mm from the apical end of the main canal was labelled (A); the coronal canal was a further 6.5 mm more coronal than (A) and was labelled (C) (Figure 1).

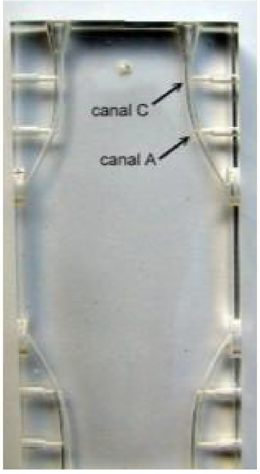


**Figure 1: The clear block with simulated curved root canals**

Both lateral canals consisted of three cylindric sections the inner section had a diameter of 0.5 mm, and length 0.2 mm (A) and 1 mm (C); the middle section had a diameter of 0.7 mm, and length 1 mm (A) and 1 mm (C); the outer section had a diameter of 1 mm. The length of each main canal was 18 mm from the surface of the resin block, its diameter at the orifice (3 mm from the surface of the resin block) was 1 mm, its diameter at the end point was 0.3 mm and its taper was 0.04 and the curvature was 25° [3].

These blocks were cut in two parts horizontally for ease of manipulation and to facilitate sample grouping resulted in 16 blocks with two main canals.

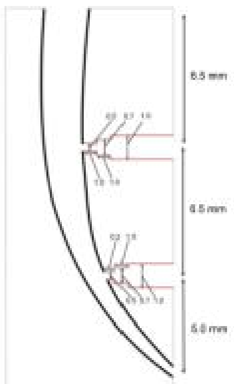


**Figure 2: Dimensions of lateral canal**

Only 15 blocks were used in the present study. The total number of simulated curved main canals used was 30 canals. Fifteen custom made blocks with two straight main canals were fabricated with the same dimension and taper of Thermafil training block but with straight canal. The total number of simulated straight main canals used was 30 canals. Computerized turnery machine was used to fabricate straight metal pins with terminal diameter of 0.3 mm and taper 0.04.

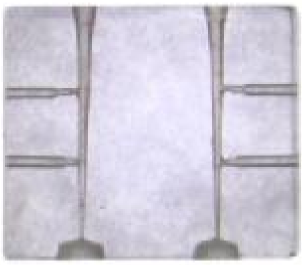

**Figure 3: Custom made block.**

These metal pins were inserted into a block of wax. Laboratory procedure (flasking, wax elimination and packing) was done to convert the wax into heat cured clear acrylic. Then high accuracy stand drill was used to prepare two lateral canals with the same dimensions and at the same locations from the apical end of the main canal to those of ready-made Thermafil training block.

The patency of all main and lateral canals was verified using a size 20 stainless steel K-file. Each canal was irrigated with 5ml of distilled water and then dried with #30 paper points [3]. To avoid bias, all blocks were covered with sticker tape, so that the operator could not see the canal while performing obturation and all obturations were made by the same operator blindly simulating clinical situation.

## Sample grouping

All 30 curved canals and 30 straight canals were divided into 6 groups(ten each) according to the method of obturation as shown in Table 1:

**Table 1: Grouping of samples.**

| No. of groups | Method of obturation | Type of canal |
|---|---|---|
| C1 | Continuous wave with E&Q master | Straight |
| C2 | | Curved |
| O1 | Obtura II | Straight |
| O2 | | Curved |
| T1 | Thermafil | Straight |
| T2 | | Curved |

Number of groups Method of obturation Type of canal C1 Continuous wave with E&Q master Straight C2 Curved O1 Obtura II Straight O2 Curved T1 Thermafil Straight T2 Curved

**Sealer application**

All canal surfaces were coated with a thin layer of liquid soap to simulate sealer cement. Liquid soap was applied by coating the canal walls using K-file #30. The liquid soap was used to lubricate the main canal walls without blocking the lateral canals and without masking off the filling material (8).

**Canals obturation**

Groups C1 and C2

Continuous wave technique of obturation using E&Q master cordless gutta-percha obturator (pen and gun) was used to obturate all the 20 canals of these two groups according to manufacturer's instructions.

The technique includes two steps, first step is downpack and second step is backfill.

1- Down pack.

Before using liquid soap into straight (group C1) and curved (group C2) canals, the master gutta-percha cone #30 and taper 0.04 was tested to full working length in the canals to be sure it goes fully to place. The cone is then removed and the corresponding finger plugger #40 was tried for size in the canal to check its "binding-point", the stopper attachment is then adjusted at the coronal surface of the block and the plugger is removed. The pen tip was also tested to be inserted into the canal and reach 5 mm from apical end of the canal. Liquid soap is applied. The master gutta-percha cone was inserted to full working length and the pen was activated to heat the pen tip and used to sear off the cone at canal orifice. The preheated pen tip was then driven smoothly through the gutta-percha to within 3 to 4 mm of its binding point in the canal. This took about 2 seconds. Maintaining apical pressure, the pen tip continued to move apically, and at that time the heat switch was released. The pen tip was held there, cooled, under sustained pressure, for an additional 10 seconds. During that period the gutta-percha flowed into lateral canals. The pressure also compensated for the shrinkage that might occur as the mass cools. To remove the pen tip, while still maintaining apical pressure, the heat switch was activated for only 1 second followed by a 1 second pause, the cold pen tip was then quickly withdrawn. Finger plugger was used to compact gutta-percha apically. Apical 5 mm at that stage was obturated and remainder of the canal was ready for backfill.

2- Backfill

At this step, the gun was switched on, loaded with gutta-percha pellet and set at temperature 200°C. A small amount of gutta-percha was extruded to warm the gun needle and discarded. The gun needle was then quickly introduced into the canal. The trigger of the gutta-percha gun was activated and thermoplasticized gutta- percha extruded into the canal, gently pushing the needle out. Three increments were applied to backfill the canals as follows: 5, 5, 3 mm. Once the canal was filled conventional hand plugger was used to compact the gutta-percha (8,9).


**Figure 4: Backfilling with E&Q Master system**

Groups O1 and O2

Samples of these two groups were obturated using Obtura II with 23-G needle using the same type of gutta-percha pellets that used in groups C1 and C2. The Obtura II device was switched on, the temperature was set at 200°C and the gutta-percha pellets were loaded into the gun. The liquid soap was inserted into the canals using K-file #30, and a small amount of gutta-percha was extruded to heat the needle and discarded.

The needle was inserted into the canal within 5 mm from the apical end and the trigger was pressed to release gutta-percha into the canal until gently pushing the needle out. The needle was removed from the canal and a finger plugger #40 was used to compact the gutta-percha apically and to compensate for cooling shrinkage. Four increments were used to fill the canal as following: 5, 5, 5, 3 mm in sequence with compaction between increments using finger plugger after first increment and hand plugger after the others (8,10).

**Figure 5: Obtura injecting soft gutta percha**

Groups T1 and T2

In these two groups, the samples were obturated with plastic carrier-based Thermafil obturators #30 according to the manufacturer's instructions. Size 30 verifier was inserted into the canal to the working length to check the ability to reach full working length. The stopper was placed on the Thermafil cone according to the working length and the cone #30 was placed in one of the heating chamber of Thermaprep plus oven (Size 30-60 button is chosen).

The heating time needed to heat gutta-percha obturators was regulated automatically by the Thermaprep plus oven (about 15 seconds); during this time liquid soap was introduced into the canal by coating the canal walls using K-file #30. After a beep sound, the oven was switched off then the cone raised and inserted inside the canal firmly and slowly to working length without any twisting or rotation and light apical pressure was maintained to overcome cooling shrinkage. The handle of the obturator was cut and removed after the gutta-percha cooled by inverted cone bur in a high speed handpiece [11].

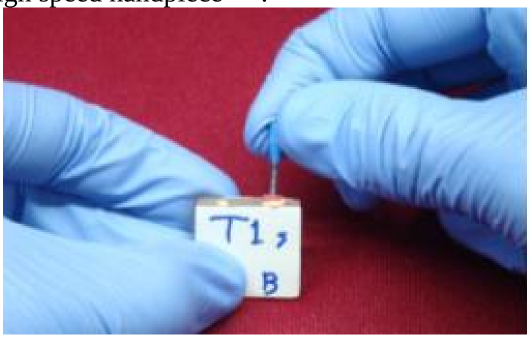

**Figure 6: Thermafil system**

**Data collection**

After the completion of obturation of all blocks, each block was examined at an original magnification of 10X by means of stereomicroscope and photographed by digital camera at special settings as recommended by the manufactures mounted on the stereomicroscope (Motic, Gloucester Road Causeway Bay, Hong Kong).

The obtained digital images were captured with built-in digital camera at a resolution of 1024x768 pixels and stored using IBM computer (IBM Corporation, Armok, New York). Motic Images Plus 2.0 software (Motic, Gloucester Road Causeway Bay, Hong Kong) that is supported with the stereomicroscope by the manufacturer was used to measure the distance from the wall of the main canal to the most far point that gutta-percha had entered into lateral canals. All measures made and readings were taken by the same trained examiner.

# RESULTS

The collected data were analyzed by descriptive statistics including minimum, maximum, means and standard deviation in millimeter for each group of obturation used in the study as shown in table 1.

**Table 1: Descriptive statistical analysis.**

| Canal type | Technique | Level | No. | Min. | Max. | Mean | SE | ± SD |
|---|---|---|---|---|---|---|---|---|
| Straight | Continuous wave | C | 10 | 4.39 | 6.46 | 5.926 | 0.18839 | 0.59575 |
| | | A | 10 | 2.70 | 3.08 | 2.884 | 0.04129 | 0.13057 |
| | Obtura II | C | 10 | 3.10 | 4.34 | 3.679 | 0.12740 | 0.40285 |
| | | A | 10 | 1.53 | 3.01 | 2.358 | 0.16571 | 0.52402 |
| | Thermafil | C | 10 | 3.86 | 4.74 | 4.467 | 0.10565 | 0.33410 |
| | | A | 10 | 1.50 | 3.16 | 1.993 | 0.17048 | 0.53912 |
| Curved | Continuous wave | C | 10 | 3.89 | 4.90 | 4.306 | 0.08863 | 0.28029 |
| | | A | 10 | 2.34 | 3.34 | 2.837 | 0.11598 | 0.36675 |
| | Obtura II | C | 10 | 2.19 | 3.61 | 3.027 | 0.16030 | 0.50691 |
| | | A | 10 | 0.66 | 1.77 | 1.148 | 0.10710 | 0.33868 |
| | Thermafil | C | 10 | 2.44 | 3.67 | 2.947 | 0.10577 | 0.33764 |
| | | A | 10 | 0.84 | 1.94 | 1.306 | 0.10314 | 0.32616 |

Table (1) shows that in straight canals, the highest mean value for gutta-percha penetration was seen in continuous wave at coronal LC (5.926 mm) followed by Thermafil at coronal LC (4.467 mm), Obtura II at coronal LC (3.679 mm), continuous wave at apical LC (2.884 mm), Obtura II at apical LC (2.358 mm) and the least was Thermafil at apical LC (1.993 mm).

In curved canals, the highest mean value for gutta-percha penetration was seen in continuous wave at coronal LC (4.306 mm) followed by Obtura II at coronal LC (3.027 mm), Thermafil at coronal LC (2.947 mm), continuous wave at apical LC (2.837 mm), Thermafil at apical LC (1.366 mm) and the least was Obtura II at apical LC (1.148 mm).

The overall highest mean value was seen in continuous wave of straight canals at coronal LC (5.926 mm) and the least mean value was seen in Obtura II of curved canals at apical LC (1.148 mm).

The results of least significance difference test (LSD) showed the following:

1. There was statistically highly significant difference between group C1 and group T1, and between group C1 and group O1 at coronal LC, and between group C1 and group T1 at apical LC.
2. There was significant difference between group C1 and group O1 at apical LC.
3. There was highly significant difference between group C2 and group T2, and between group C2 and group O2 at both coronal and apical LC.
4. There was highly significant difference between O1 and T1 at coronal LC. 5. There difference was non-significant between O1 and T1 at apical LC. 6. There difference was non-significant between O2 and T2 at both coronal and apical LC.

**Table 2: LSD test for gutta percha penetration among the three obturation techniques in different main canal types at each level.**

| Canal Type | LC Level | Studied Groups | | LSD Test P-value | LSD Test Sig. |
|---|---|---|---|---|---|
| Straight | Coronal | C1 | O1 | 0.000 | **HS |
| | | | T1 | 0.000 | **HS |
| | | O1 | T1 | 0.001 | **HS |
| | Apical | C1 | O1 | 0.013 | *S |
| | | | T1 | 0.000 | **HS |
| | | O1 | T1 | 0.075 | NS |
| Curved | Coronal | C2 | O2 | 0.000 | **HS |
| | | | T2 | 0.000 | **HS |
| | | O2 | T2 | 0.648 | NS |
| | Apical | C2 | O2 | 0.000 | **HS |
| | | | T2 | 0.000 | **HS |
| | | O2 | T2 | 0.168 | NS |

NS= non-significant *S= significant **HS= highly significant

An explanation for these results might be attributed to that in Continuous Wave technique at downpack phase, because of the tapered pen tip the gutta-percha was compacted laterally as well as vertically. This would force the gutta-percha deeper into LC (3). Also the master cone provided sufficient amount of gutta-percha that penetrated into LC as compared with Thermafil technique in which plastic carrier comprise part of the obturator mass especially at apical LC.

The results showed that in straight main canals at coronal LC group T1 had greater mean gutta-percha depth value compared with group O1 and the difference was statistically highly significant. At apical LC there was non-significant difference between group O1 and group T1 techniques. This might be attributed to that the plastic carrier of Thermafil obturator provides lateral compaction that pushed gutta-percha into LC.

In curved main canals, the results showed that the mean value of gutta-percha penetration depth was better in group O2 than in group T2 at coronal LC; while at apical LC it was higher in group T2 than in group O2; however, there was non-significant difference between group O2 and group T2 at both coronal and apical LC.

As conclusion,

1. All thermoplasticized gutta-percha obturation techniques used in the present study had the ability to obturate lateral canals.
2. Continuous wave obturation technique was better in obturation of lateral canals than Obtura II and Thermafil in both straight and curved main canals.
3. Location of lateral canal could influence its ability to be obturated. Coronal lateral canals were much easier to obturate than apical lateral canals of both straight and curved main canals in all obturation techniques used.
4. Straight root canals allowed greater ability to obturate lateral canals than curved root canals, regardless of the obturation technique used.

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