



## Comparison of Apical Adaptation Between Several Obturation Methods: An in Vitro Study

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### Abstract

**Objective:** To compare lateral compaction obturation with carrier-based gutta-percha and downpack-backfill. **Material and Methods:** Ninety tooth with single root canal were prepared with rotary Protaper and divided into 3 groups: Group 1 obturated with lateral heated compaction (LHC), Group 2 with carrier-based gutta-percha (CP) and Group 3 with downpack-backfill (DB). The apical one-third adaptation was determined by examining the dye penetration between obturation material and root canal wall on the horizontal cut samples. The data received was analyzed using SPSS 17 software. Chi-square statistical test was done with level of significance ( $\alpha$ ) of 0.05. **Results:** The DB group had the highest amount of score of 0, followed by CP group and LHC group. The DB group had 28 samples (93.3%) with score of 0, which was the largest compared to the CP and LHC group. All groups had some score 2, and score 3 and 4 were only examined in the LHC group. Adaptation of the apical one-third on DB group had the best result, followed by CP and LHC group ( $p > 0.05$ ). **Conclusion:** The adaptation of apical one-third by downpack-backfill was the best among the three groups, but there was no statistically significant difference among those groups.

**Keywords:** Root Canal Obturation; Root Canal Therapy; Endodontics.

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## Introduction

The purpose of root canal obturation phase of endodontic treatment is to prevent re-infection. Successful obturation is hermetic along the entire root canal system and providing a fluid-tight seal from the apical segment of the canal to cavo-surface margin to corresponding monoblock concept. It has been shown that endodontic treatment success is dependent both on the quality of the obturation and the final restoration [1]. The main cause of endodontic failure is faulty obturation [2,3]. This statement supports findings which states that 60% of endodontic treatment failure are due to error in obturation [4].

Obturation technique using heated gutta-percha can improve seal quality; the technique can produce homogeneous root canal obturation [5,6]. There are several methods of obturation with heated gutta-percha, such as heated lateral compaction technique and carrier-based gutta percha technique with success rate of 85% [7]. There is another technique called Downpack-backfill compaction technique, which is a combination of vertical (downpack) and thermoplastic injection (backfill) [8]. This technique produces hermetic obturation of main root canal & the accessory canals and has a low risk of fracture on the root canal area [3,9,10].

This research compared the adaptability on the edge of the apical third of three obturation techniques with heated gutta-percha: lateral compaction technique, carrier-based gutta-percha and downpack-backfill.

## Material and Methods

It were used ninety (90) extracted human tooth samples with single root canal. After the extraction, the samples were directly soaked in a solution of NaCl 0.9% (Otsuka B. Braun Medical Industries, Sdn. Bhd Penang, Malaysia). Crown section of the tooth is cut on the cervical part, then working length was determined 1 mm from the apical foramen using a K-file #10 (Dentsply/Maillefer, Ballaigues, Switzerland).

Root canal preparation with a crown down technique was done using rotary ProTaper (Dentsply/Maillefer, Ballaigues, Switzerland) until F2 was reached. Solutions used for irrigation during root canal preparation were 2.5% NaOCl & 17% EDTA (MD-Cleanser, Meta Biomed. Co, Ltd. Cheongju City, South Korea), while the sealer used was AH Plus (Dentsply/Maillefer, Ballaigues, Switzerland).

Samples were divided into 3 groups, with each group consisted of 30 samples:

- Group 1: Underwent obturation with lateral heat compaction technique (LHC); after application of the sealer, ISO-standardized gutta-percha cone #02/25 was inserted into the root canal to working length as the main cone. Next, lateral compaction was done with Dual Calamus Pack handpiece (Dentsply/Maillefer, Ballaigues, Switzerland), then accessory gutta-percha cones were added into the canal until solid obturation had been reached.

- Group 2: Underwent obturation by carrier-based gutta-percha (CP); Thermafil gutta-percha #25 (Dentsply/Maillefer, Ballaigues, Switzerland) that had been heated in a special oven was inserted into the root canal with light pressure until it reached the working length.
- Group 3: Underwent obturation with downpack-backfill technique (DB), the gutta-percha cone ProTaper F2 was inserted into the root canal until it reached the working length. Using Dual Calamus Pack handpiece, a part of coronal gutta-percha was cut until 3-4 mm gutta-percha left at the third apex and then the mass was compacted vertically. Dual Calamus Flow handpiece was used to obturate space in the coronal two-thirds of the root canal.

The coronal parts of all samples were restored with glass ionomer cements and the density of obturation was evaluated with radiographs. All samples were incubated for 7 x 24 hours at 37°C with a humidity of 100% in 0.9% NaCl solution. Tooth root surface was coated by two layers of nail polish except 2 mm from the apical ends. After 24 hours the samples were immersed in India ink for 7 x 24 hours at 37 °C. The samples were then washed under running water and then were cut cross-sectionally at the 2 mm and 4 mm from the apex, similar to method previously described [11].

The adaptation of obturation was examined using a stereomicroscope (Carl Zeiss Microscopy GmbH, Jena, Germany) with 50x magnification. Adaptation at the end of the apical third was assessed by looking at the extent of dye penetration between obturation material and the canal walls (Figure 1), as previously described [12] which used a five-score system: 0 (no slit edge), 1 (there is a gap edge on one quadrant), 2 (there is a gap edge on the two quadrant), 3 (there is a gap edge on the three quadrant) and 4 (there is a gap at the edge of the entire quadrant or absence of adaptation) [12].

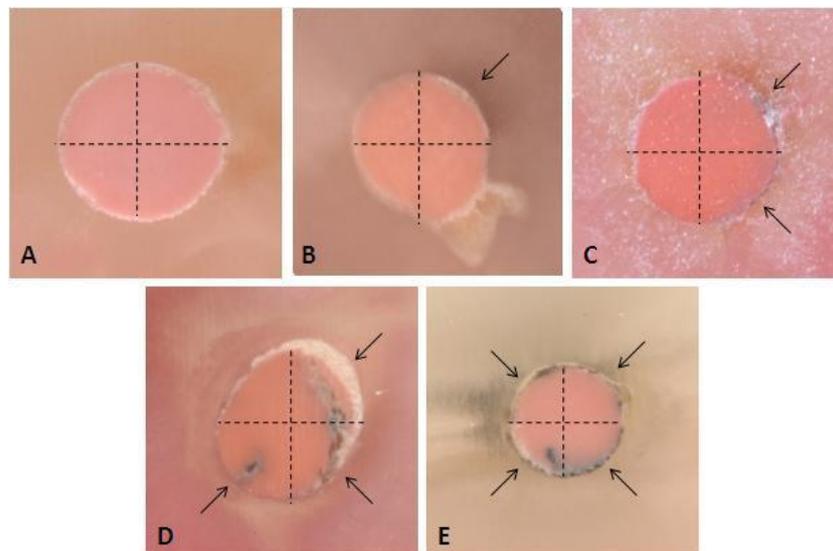


Figure 1. A: Score 0; B: Score 1; C: Score 2; D: Score 3 and E: Score 4.

#### Data Analysis

Data were analyzed using IBM SPSS Statistics for Windows Software, version 17 (IBM Corp., Armonk, NY, USA). Chi-square statistical test was done with level of significance ( $\alpha$ ) of 0.05.

## Ethical Aspects

The study was approved by the ethical committee of Faculty of Dentistry, Universitas Indonesia.

## Results

In Table 1 shows that among all groups, the DB group had the highest amount of score of 0, followed by CP group and LHC group. The DB group had 28 samples (93.3%) with score of 0, which was the largest compared to the CP and LHC group. All groups had some score 2, and score 3 and 4 were only examined in the LHC group. LHC Group was shown to have the most variable leak rate.

**Table 1. Distribution of scores between groups.**

| Technique | Region | Score |       |   |      |   |      |   |     |   |     |
|-----------|--------|-------|-------|---|------|---|------|---|-----|---|-----|
|           |        | 0     |       | 1 |      | 2 |      | 3 |     | 4 |     |
|           |        | N     | %     | N | %    | N | %    | N | %   | N | %   |
| LHC       | 2 mm   | 22    | 73.3  | 1 | 3.3  | 4 | 13.3 | 1 | 3.3 | 2 | 6.7 |
|           | 4 mm   | 26    | 86.7  | 0 | 0.0  | 4 | 13.3 | 0 | 0.0 | 0 | 0.0 |
| CP        | 2 mm   | 25    | 83.3  | 3 | 10.0 | 2 | 6.7  | - | -   | - | -   |
|           | 4 mm   | 29    | 96.7  | 1 | 3.3  | 0 | 0.0  | - | -   | - | -   |
| DB        | 2 mm   | 28    | 93.3  | - | -    | 2 | 6.7  | - | -   | - | -   |
|           | 4 mm   | 30    | 100.0 | - | -    | 0 | 0.0  | - | -   | - | -   |

LHC = Lateral Heat Compaction; CP = Carrier-Based Gutta-Percha; DB = Downpack-Backfill.

In Table 2 shows no significant differences between results of the three groups. So it can be concluded that all three groups have the same obturation adaptability at the apical edge.

**Table 2. Comparison between groups.**

| Comparison | p-value |
|------------|---------|
| LHC vs CP  | 0.192   |
| LHC vs DB  | 0.363   |
| CP vs DB   | 0.150   |

LHC = Lateral Heat Compaction; CP = Carrier-Based Gutta-Percha; DB = Downpack-Backfill

## Discussion

The goal of three-dimensional obturation is to provide impermeable, fluid-tight seal within the entire root canal system, preventing oral and apical microleakage. In this study, for the uniformity of the sample, the investigators used human teeth with single root canal and had been completely erupted.

In this research, the procedures adopted were the same as those described in other studies. Part of a dental crown was cut to same length for all the samples. Working length was determined 1 mm from the apex foramen using a K-file #10 in order to create apical stop [13]. Proper root canal preparation provides an apical resistance form for the adequate adaptation of filling materials and the prevention of excessive apical extrusion of these materials. Prior to the obturation phase, proper shape and size of the root canal were determined. The root canal preparation used rotary Protaper instruments #8 with a large taper to facilitate obturation of the root canal [14].

The purpose of endodontic irrigation is to remove debris created during instrumentation, and to dissolve and/or flush out inorganic and organic remnants of the pulp system, bacteria and its by-products. Irrigation by 2.5% NaOCl was done during instrumentation, and after instrumentation was completed, ending with 17% EDTA irrigation for 2 minutes [15]. The objective was to effectively remove smear layer, so optimal sealer penetration into the dentin tubules could be achieved [16,17].

Sealers were used between dentin surfaces and core materials to fill spaces that are created due to the physical inability of the core materials to fill all areas of the canal. Epoxy resin sealer was used in this study because it was adhesive and had the highest strength and sealing ability [17]. Combination of gutta-percha and epoxy resin sealer will produce good adaptation at the edge of canal [1]. The use of heated gutta-percha will produce better adaptation and will result in homogeneous, solid obturation [5,9].

There are alternative methods of obturation and each claim to be superior to mechanical lateral heated condensation. Carrier-based gutta-percha technique is able to fill irregular root canal [6,17,18]. But it is likely to strip gutta-percha from the carrier, leaving the carrier inside the apex of the root canal [17-19]. Downpack-backfill technique is a combination of vertical compaction (downpack) and thermoplastic injection (backfill) [9]. The downpack-backfill technique can hermetically fill main root canal and the accessory canals [10]. However, the shortcomings of this technique are more difficult procedure and require more varied instruments [17,18].

The downpack-backfill technique is done in two steps: first, the continuous wave is used to get a seal on the third apex, followed by thermoplastic injection for two-thirds coronal of the root canal. By continuous wave compaction, electric heat source is inserted into the root canal to 3-5 mm of working length and gutta-percha is compacted, providing hydraulic pressure for gutta-percha, which has already softened toward the apex. Adaptation was not very good on the LHC group may be due to the use of master and accessory gutta-percha coupled with the use of heated instrument allows the unequal distribution of heat to all sides; so that the homogeneity between gutta-percha cones was not achieved and lead to a gap between the canal wall and gutta-percha [10,17]. This was supported by a research that compared downpack-backfill technique using Bee-Fill 2-in-1 with a carrier-based gutta-percha technique using GuttaMaster [20]. The leakage rate of Bee-Fill 2-in-1 (1:29) was lower compared to GuttaMaster (1:32), but it was not a statistically significant difference [20].

When the results of all three groups were compared as shown in Table 2, no statistically significant difference was examined ( $p \leq 0.05$ ). The warm and soft gutta-percha allows homogenous distribution of the filling into the apical third of the root canal system. Gutta-percha cones must be plasticized to become adapted to the canal; however, it should not be too soft in order to allow control of the material. Two aspects influence the degree of softening: (1) the necessity to reach all narrow and small spaces that require a soft gutta-percha, and (2) the clinical necessity of precise positioning of the cone at the apex in particular when the patency of the orifice was maintained.

Moreover, with very soft gutta-percha, the pluggers would penetrate into the material rather than compact it. This is consistent with research that compared the lateral compaction technique heat (Touch 'n Heat) and carrier-based gutta-percha (Thermafil) [21]. The findings of previous research showed no significant difference between the lateral compaction and carrier-based gutta-percha technique [21].

The study used conventional method to analyze the apical adaptation because the limitation of tools provider in our area and it is simple to follow. Assessment of dye penetration is a common method used to evaluate apical adaptation of root fillings. The success of this method depends on the marker. The marker used in this study was India ink because it has a low molecular weight and penetrates more deeply along the root canal filling. Recent studies showed better analysis using micro-CT technique.

Therefore, the results of this study can be used as a guide to choose the root canal obturation technique that produces hermetic and fluid-tight seal.

## Conclusion

Downpack-backfill technique has better adaptation compared to carrier-based gutta-percha and lateral heated compacting technique. However, all three techniques have no statistically significant difference.

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