

# Comparative Evaluation of Apical Microleakage of Various Obturation Techniques using Single Cone Gutta-percha, Lateral Condensation, Obtura, Calamus and Thermafil by Dye Penetration Method

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## ABSTRACT

**Aim:** To determine the linear apical microleakage of various obturation techniques: Lateral condensation, single cone, obtura, calamus, and thermafil with different file systems using dye penetration.

**Materials and methods:** A total of 150 single canal teeth were collected for this study. The teeth were prepared by three file systems and obturated with five obturation techniques. Dye penetration method was used for apical microleakage.

**Results:** Calamus and thermafil showed less leakage than other obturation techniques.

**Conclusion:** Both thermafil and calamus are reliable obturation techniques.

**Keywords:** Apical microleakage, Calamus, Lateral condensation, Obturation techniques, Thermafil.

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## INTRODUCTION

The search for an ideal root filling material is not new in dentistry. The material avoids the seepage of oral fluids or other materials into the periapical area. Thus, the importance of an ideal filling material cannot be questioned. Gutta-percha was introduced in dentistry. The leakage through this material is of utmost importance

and should be carefully investigated. Thus, through this study, we tried to investigate the quality of obturation we can achieve using modern techniques in comparison with the traditional ones.

Complete obturation of the root canal with an inert filling material and creation of a hermetic apical seal are the goals of successful endodontic treatment.<sup>1</sup> Certain principles are followed to achieve proper shaping and cleaning, which include: Preoperative assessment of the tooth for the number of canals present, canal location and number, any curvature or calcification and any variation in the anatomy of the root canal system.

Cold lateral compaction is still the standard to which other techniques are compared. In 1967, Schilder described warm vertical compaction as an alternative to cold lateral condensation with the idea that compaction of thermoplasticized gutta-percha would permit full adaptation of the gutta-percha to the anatomical complexities of the root canal.

In 1978, McSpadden introduced thermo-mechanical compaction technique.<sup>2</sup> A rotating compactor created frictional heat inside the root canal and plasticized a cone of gutta-percha that was forced laterally and apically to obturate the root canal.

Root canal preparation with rotary nickel-titanium (NiTi) instruments has become popular. It has been reported that rotary NiTi instruments shape the root canals easily, quite rapidly, and more predictably while reducing the procedural errors and maintaining the original curvature of the root canals.<sup>3</sup> Additionally, preparation of the root canal with rotary instruments may improve the adaptation between the gutta-percha point and the canal wall, because the flexible NiTi instruments may result in less straightening and flaring of curved canals compared with the use of stainless steel instruments.<sup>4,5</sup> Furthermore, the use of rotary instruments may improve preparation of a uniformly round space compared with circumferential filling with hand instruments, although the cleaning efficacy may depend on canal morphology.<sup>6,7</sup>

Various methods have been used to assess and estimate sealing quality of the restorations. Commonly used tracers are dyes, radioisotopes, and bacteria and

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their products, such as endotoxins. Other methods, such as fluid filtration and dye extraction methods have also been used due to their advantages. Thus, through this study, we tried to investigate the quality of obturation we can achieve using modern techniques comparing with the traditional ones.

## MATERIALS AND METHODS

### Specimen Selection

As many as 150 single canal teeth were collected from Department of Oral and Maxillofacial Surgery for this study. The teeth were stored in 10% formalin solution until use. The teeth were similar in canal curvatures, similar in length and size that could represent similar clinical situations.

### Canal Preparation

After establishing the glide path with number 15 k file, canals were prepared using crown down technique. X Smart Plus (Dentsply Maillefer, Ballaigues, Switzerland) endodontic motor was used while using Protaper (Dentsply Maillefer, Ballaigues, Switzerland), Wave One Files (Primary) (Dentsply Maillefer, Ballaigues, Switzerland) and F360 File System. Every canal was prepared for 7 minutes. During instrumentation, canals were irrigated with 2 ml 5% NaOCl and 17% EDTA (Anabond Stedman) delivered through 25 gauge needle. The residual irrigants were removed with a final rinse of 9 ml of distilled water. Canals were dried with absorbent paper points (Dentsply Maillefer, Ballaigues, Switzerland).

### Obturation

#### Group 1 – Lateral compaction

The teeth were dried with paper point. A master apical gutta-percha cone of the same size as the apical instrument was chosen so that it reaches 1 mm short of the apex but did not penetrate through the apical foramen. A radiograph ensured the fit of the primary point. The premeasured master cone was then coated with the sealer and slowly moved to the full working length.

The spreader was used to laterally condense the accessory gutta-percha cones till a well-condensed mass of gutta-percha was obtained. Vertical compaction with a large plugger was then followed. The excess gutta-percha points that were protruding from the access cavity were resected by a hot spoon excavator, followed by slight vertical compaction of the material at the access cavity. The access opening was then sealed by Cavit G (ESPE Germany).

#### Group 2 – Single cone

Gutta-percha cone corresponding to the file system used was coated with AH Plus sealer and inserted into the canal to the full working length. Excess cone is cut with a heated instrument.

#### Group 3 – Calamus

*Downpack:* The Calamus Electric Heat Plugger was activated and utilized to sear off the master cone at the orifice. To capture the maximum cushion of warm gutta-percha, the working end of the large size prefit plugger was methodically stepped around the circumference of the canal. This plugger was used with short, firm vertical strokes to scrape warm gutta-percha off the canal walls and flatten the material coronally. The working end of the plugger was used to vertically press on this flattened platform of warm gutta-percha for 5 seconds.

To generate a progressively deeper heat wave along the length of the master cone, the Calamus EHP was activated and allowed to plunge 3 to 4 mm into the previously compacted material. Removing a bite of gutta-percha results in the progressive apical transfer of heat another 4 to 5 mm along the length of the master cone and facilitates the placement of the medium size prefit plugger deeper into the root canal preparation. This plugger was used, as described earlier, to compact warm gutta-percha into this region of the canal.

*Backfill:* A new cartridge was inserted into the heating chamber and secured by tightening the cartridge nut. When the Calamus Flow handpiece was activated, an internal plunger starts moving toward the heating chamber and the cartridge. In this manner, the plunger serves to push thermosoftened material out of the heated cartridge, through the canula, and into the canal.

The tip of the warm canula was positioned against the downpacked gutta-percha for 5 seconds to re-thermosoften its most coronal extent. The Calamus Flow handpiece was activated and a short 2 to 3 mm segment of warm gutta-percha was dispensed into the most apical region of the canal.

The small size prefit plugger was used, as previously described, to densely compact warm gutta-percha into this region of the canal. This step was repeated 2 to 3 times, until the canal was fully obturated.

#### Group 4 – Obtura

The canals were coated with very little quantity of sealer to avoid pooling. The gutta-percha pellets were loaded into the syringe and the temperature control on the unit was adjusted to 160 degrees. The 23-gauge-injection needle was placed within 3.5 to 5 mm of the working

length and the canal was totally filled as the needle is withdrawn. Vertical condensation was done with endodontic plugger with a drop of sealer at its tip to avoid adhering to the gutta-percha.

#### Group 5 – Thermafil

The teeth were dried with paper point. Then a verifier (Maillefer – densply) was used to determine the proper size and X-ray was taken to see the fit of the verifier, then a Thermafil obturator was selected according to the size of the Verifier (Size no. 50). By using the calibrations on the carrier, adjustment of the rubber stopper on the obturator was done. The thermaprep was heated for 15 seconds with obturator. During which the AH Plus sealer was placed by a lentulo spiral and then the obturator was inserted to the working distance with firm apical pressure without twisting or rotating, while stabilizing the handle with the index finger, serving the shaft with a round bur with the canal orifice, and sealing the access opening by Cavit G.

Following obturation, the root surfaces of all samples were coated with two coats of nail paint up until the apical 2 mm. The teeth were left undisturbed in 2% methylene blue solution for 72 hours. After removing from dye solution, the specimens were washed with water and dried.

The teeth were then sectioned vertically along the long axis in the bucco-lingual direction through the center of the root. The samples were then observed under a stereomicroscope (Figs 1 and 2).

## RESULTS

The teeth obturated with thermafil and calamus showed least leakage as compared to the other groups. The mean values were statistically significant when compared with other groups.



Fig. 1: Radiograph of sample obturated with Thermafil

## DISCUSSION

Gutta-percha has been used for root canal filling for more than a century. Many techniques have been introduced over the years for efficient and effective filling of the root canal space with gutta-percha.<sup>8</sup> This study was designed to evaluate the linear apical microleakage of five obturation techniques using three instrumentation systems.

We compared the three rotary instrumentation systems in our study to check whether the instrumentation technique had any influence on the leakage. Our results showed that the rotary system used had no significant effect on the amount of leakage. Similar results were shown by Tasdemir et al,<sup>9</sup> when they used Protaper and Mtwo rotary systems. We used a 4% taper system (F360) to check if the taper had any effect on obturation quality. Another system that we used, Waveone, is used in a reciprocating motion. Our results showed that the taper and motion had no effect on the obturation quality. This may be attributed to the matched gutta-percha cones corresponding to the file system used (File System).

The results of a study by Zapate RO showed that the carrier-based techniques presented more than 90% of sealer penetration into dentinal tubules at the levels evaluated. These results can be explained by the high percentage of gutta-percha-filled area commonly found in laboratory research that uses carrier-based techniques. Therefore, it should be expected that a thinner layer of sealer would be found, consequently increasing the percentage of sealer penetration to the root canal walls. When we compared the different obturation techniques, we found that the calamus and thermafil were superior to other techniques. Xu Q et al<sup>10</sup> showed similar results when they showed that the warm vertical compaction and thermafil showed better sealing ability than lateral compaction.

Single cone filing of root canals has recently been popularized through the introduction of greater taper



Fig. 2: Stereoscopic image of sample obturated with Obtura

cones, which closely match the geometry of the rotary instrumentation systems.<sup>11</sup> When we compared the lateral compaction with the single cone gutta-percha, we found a similar sealing effect. Gordon et al<sup>12</sup> and Yilmaz et al<sup>13</sup> showed similar results when they compared the apical seal of the two techniques. However, when Tasdemir et al<sup>11</sup> evaluated the percent gutta-percha-filled area, they found that single cone gutta-percha may yield better filling.

Many *in vitro* methods have been used to evaluate the sealing ability of root canal filling materials by using dyes, scanning electron microscopy, fluid filtration techniques, electrochemical methods, radioisotopes, and bacteria.<sup>12-16</sup>

In our study, we used the methylene blue dye penetration method with longitudinal sectioning for viewing. Grossman in 1939 first reported the methodology using tooth immersion in various types of dyes (eosin, methylene blue, black India ink, Prcion brilliant blue). Other techniques such as bacterial studies or fluid filtration method are qualitative rather than quantitative.<sup>17</sup>

## CONCLUSION

Through our *in vitro* study, we can conclude that the carrier-based (Thermafil) and continuous wave of condensation techniques (Calamus) lead to less penetration of fluid over the other techniques. However, further *in vivo* studies are necessary to confirm these results and evaluate their relevance to treatment outcome.

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