# Comparison of Bacterial Leakage between 3 Different Root Canal Obturation Techniques in Oval Shaped Canals

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## Abstract

**Introduction:** The purpose of this study was to evaluate the sealing ability of 3 obturation techniques in oval-shaped canals by bacterial leakage assessment. **Methods:** Sixty mandibular incisors with oval canals were selected after providing buccolingual and mesiodistal radiographs. The teeth were sectioned at a 10 mm distance from the apex. After instrumentation, the teeth were divided into 3 groups and the canals in the three groups were obturated with lateral condensation (G1), warm vertical condensation (G2) and thermoplasticized injectable gutta percha (G3). The teeth were exposed to human saliva. Observing the turbidity of the BHI broth for a period of 63 days the number of days required for the complete contamination of root canals was recorded. The data were analyzed using descriptive statistical methods and Kruskal-Wallis test with SPSS statistical software. **Results:** Warm vertical condensation (G2) needed a significantly greater average time for leakage than the two other methods. No significant differences were found between lateral condensations and thermoplasticized injectable G.P techniques. **Conclusion:** warm vertical condensation provides a better seal against bacterial leakage than lateral condensation and obtura II method in obturating oval-canals.

**Key words:** Bacterial leakage, lateral condensation, obtura, oval canal, warm vertical condensation.

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## Introduction

Root canal therapy contains root preparation and obturation. The purpose of obturation is to prevent the communication between the oral cavity and periradicular tissues (1). Three-dimensional filling of root canal space is required to achieve long term success. The root canal system should be sealed in coronal, apical, and lateral sides (2). An adequate filling plays an important role to inhibit bacterial leakage (3). Apical seal, is a critical factor in root canal therapy, and more than 50% of root canal failures are due to insufficient filling of root canal space (4). The oval shape of root canals is a prevalent finding in the five mm distance of the apex (5). Oval shaped canals are characterized by a buccolingual to mesiodistal proportion of 2 or more at the 5 mm distance of the apex (6). The short term seal of the canal may affected by the root canal form (7). The oval geometry, is possibly the main reason for higher rate of under-preparation in such root canals (8). Multiple techniques have been proposed to achieve a complete filling of the root canal space. Presenting a technique as an standard, requires more

studies that evaluate its sufficiency of filling and sealing the root canal space (9).

Lateral condensation technique, is the well-known usual technique vastly used by dentists (10-12). Vertical condensation was presented with the purpose of making more density of gutta percha in the apical region and also establishing a three-dimensional leakage-free filling in the root canal space (13).

The first invented thermoplastic injectable gutta-percha system was the Obtura system. Obtura II unit is the injectable gutta percha system with high temperature, heating the gutta percha pellets up to 150-200 degrees of centigrade in the injection gun prior to injection into the canal space (14).

Considering the anatomic variations in root canal systems and the need for further studies to compare the different proposed obturation techniques, this study was aimed to compare the apical bacterial leakage following root canal filling, between three obturation techniques containing lateral, vertical, and thermoplastic technique in oval shaped canals.

## Materials and Methods

170 mandibular incisors were collected for this in vitro study. According to the inclusion criteria of the study which required single canal teeth with oval roots, lack of caries and cracks, and no signs of resorption or calcification, and also considering the sample size which was estimated based on similar studies, 60 teeth were selected for the experiment. To verify the number and shape of the root canals, two radiographs were provided in buccolingual and mesiodistal planes by De-Deus et al. method (15). To assimilate the radiographic magnification, all radiographs were taken in a 5 cm distance between the radiographic tube and the tooth. The canals were diagnosed as oval shaped if the ratio of long/short diameter $\geq 2$ existed in the 5 mm distance of the apex. After cleansing and debridment, the teeth were stored in a 5.25% NaOCl solution for 12 hours.

10 mms of the apical root was cut with a diamond disk. A #15 K-file ((Maillefer, Ballaigues, Switzerland) was driven into the canal from the coronal access until the end of the file could be seen at the apical cut end. This length minus 1 mm was determined as the root canal length. The canals were prepared by step back method. The canals were rinsed by 2.5% NaOCl during instrumentation. In all samples, a K-file #30 was considered as MAF (Master Apical File). Flaring was done up to #80 K-file. The samples were randomly divided into three groups of 20 each.

After autoclaving process of the teeth and under sterile condition (sterile gloves and instruments, working under the hood, gutta percha sterilized in 5.25% NaOCl, three methods of obturation were respectively done in three groups:

Group 1. Cold lateral condensation, using AH26 sealer (Dentsply, Detrey Gmbh, Germany).

Group 2. Warm vertical condensation (Schilder's method), using AH26 sealer.

Group 3. Thermoplasticized injectable GP (obtura II method, using AH26 sealer.

All samples were kept in 100% humidity (water soaked sterile gas) at the temperature of 37 degrees of centigrade for 14 days, in order to achieve complete setting of the sealer (16). Preparing the samples for leakage evaluation

A two-chamber setup was used to evaluate the bacterial leakage. Two layers of nail varnish were applied all over the external surface of teeth but around the apical foramen and canal orifices. This was done to prevent the bacterial leakage through the lateral canals or cementum cracks. The pistons of sixty 20cc syringes were separated. A hole was made at the end part of syringes and all samples were fixed in the holes with their orifices inside the syringe space and the apices to the outer side. The gap between the sample and the syringe was completely sealed with a cyanoacrylate adhesive and two layers of nail varnish. The inner space of the syringe was considered as the upper chamber of the leakage verification setup in which the bacterial source or saliva was poured. As for the lower chamber, penicillin vials were used. The silicone bonnets of the vials were punched based on the syringe end size. The syringes went into the vials in a way that the tooth sample apices had a 5 mm distance to the bottom of the vial. The gap between the syringe and the vial bonnet were sealed by adhesive and nail varnish. The vials were filled by Brain Heart Infusion Broth (BHI) (Pronadisa, CPNDA, Spain) to the height that 2 mm of the tooth apex was soaked in BHI. BHI was made by mixing the pre-ordered weight of the powder in a proportionate volume of distilled water according to the manufacturer. To achieve a homogenic, clear solution, a hot water bath was used. The BHI solution was autoclaved prior to being used.

The two chamber setup was sterilized as follows:

The upper chamber (the tooth carrier syringe connected to the vial cap) was packed and sterilized by ethylene oxide gas. The lower chamber was autoclaved after closing the vial heads by cotton caps. Ultimately, the sterilization of the connection between the chambers was done adjacent to flame and the gap was sealed by nail varnish. To make sure complete decontamination was achieved, the setups were incubated at the temperature of 37°C for 7 days. During this period, only one sample showed evidence of turbidity which was sterilized and incubated in a second cycle.

After ensuring the setup sterilization, the mixture of human saliva and BHI (1 to 1 ratio) was poured into the syringes. The culture process began as the 60 setups were incubated in 37°C for 63 days. During the culture period, the samples were observed for any evidence of turbidity each 24 hours. The saliva content of the upper chamber replenished every three days. Each time, the saliva was obtained from the same person.

In case of turbidity, the sample code and the day of turbidity were recorded. To insure that the turbidity has occurred as a result of bacterial leakage, a blood culture was provided to approve the bacterial growth.

## Results

At the end of the 63 days, 85% of the samples in group 1 (cold lateral condensation), 80% of the samples in group 2 (warm vertical condensation), and 95% of the samples in group 3 (thermoplastic injectable obtura II technique) showed evidence of leakage. The descriptive data are shown in Table 1.

As the Table illustrates, the mean day of leakage occurrence is different among the three groups. One way analysis of variance (one-way ANOVA) test showed that this difference was significant ($P \leq 0.001$). As the hypothesis of variance equality was not confirmed, the non-parametrical Kruskal-Wallis test was used which showed a significant difference ($P \leq 0.001$).

Table 2 shows the significance of mean difference of the leakage day (multiple comparisons) among the three groups.

As the Table illustrates, at the significance level of 0.05, the mean differences between the groups 1 and 2, and also 2 and 3 are significant. There is not a significant difference in the mean leakage day between groups 1 and 3.

According to the results of this study the warm vertical and the thermoplastic obtura II techniques show the maximum and minimum day of leakage occurrence respectively. In warm vertical technique, more number of the samples showed no leakage during the experiment in comparison to the two other groups.



**Table 1.** The descriptive indices in 3 groups of obturation methods

| Group number | Mean day of leakage + SD | Confidence interval | |
|---|---|---|---|
| | | Up limit | Low limit |
| Group 1 | 7.4+9.1 | 12.1 | 2.7 |
| Group 2 | 16.6+17.5 | 12.1 | 7.2 |
| Group 3 | 3.5+3.3 | 5.2 | 1.9 |

**Table 2.** Comparison of mean difference among three groups

| Groups | Mean difference | Level of significance* |
|---|---|---|
| Group 1 and 2 | 9.1 | 0.023 |
| Group 2 and 3 | 13 | 0.001 |
| Group 1 and 3 | 3.8 | 0.303 |

*values less than 0.05 are considered as significant

## Discussion

In this experimental study, we compared the bacterial leakage in three types of obturation methods in oval shape canals. According to our results, the least and the most percentage of leakage occurrence in the samples after 63 days were seen in warm vertical compaction, and thermoplastic injectable obtura II techniques, respectively. The average time for leakage occurrence was significantly longer in the warm vertical compaction method in comparison to the two other methods. After all, we suggest the warm vertical compaction technique as the obturation method of preference in oval shaped canals from the aspect of bacterial leakage.

Anatomic variations of the canal shape are challenging to endodontic treatment. Oval shape canals, with a prevalence of 25%, and mostly seen in mandibular incisors and maxillary second premolars, may have a higher number of residual bacteria as a result of unpredictable preparation (17,18). This is a good logic for finding the best method of obturation that is able to compensate the unevenness of such canal shapes.

Kersten et al. (19) stated that although both cold lateral and warm vertical compaction techniques are accepted methods of obturation in endodontics, the obturation quality may be different in various anatomies of the canals. Previous studies have focused on the comparison between obturation methods in oval shape canals. In 2001, Gilbert et al. (20) compared the two methods of vertical and lateral compaction in obturation of oval shape canals by both bacterial and dye leakage techniques. Although they found no significant difference by the dye leakage method, bacterial leakage was significantly less in vertical compaction.

In 2004, Vizgirda et al. (21) using the dye leakage method, found no significant difference in the quality of obturation, between the cold lateral and thermoplasticized gutta-percha techniques.

Dye leakage has been the method of preference to evaluate the quality of canal obturation for many years. As the results of this evaluation have not been completely reliable, microbial culture has been used later to present more accurate and reproducible results. Human saliva is usually used as the bacterial source – as in our study- to assimilate the real clinical condition (19).

Shipper et al. (22) in 2004 found no significant difference in the mean microbial leakage rate between warm vertical and obtura II obturation methods. Insignificantly, the leakage rate was higher in obtura II method which may be considered in accordance with our study. In 2007, De Deus et al. (15) found no significant difference in bacterial leakage between two groups of warm vertical and cold lateral compaction.

Despite being more difficult and time consuming, warm vertical compaction has been admired as a method of offering obturation of highest quality, many times to a significant level, in several studies including ours.

Warm vertical method has shown a 10% more clinical success, in comparison to cold lateral method in cases of apical periodontitis (23). In 2006, Collins et al. (24) showed that warm vertical compaction has a higher ability to fill the defects of the canal system in comparison to the cold lateral method. Qiong Xu et al. (16) showed that more glucose leakage occurs in cold lateral in comparison to warm vertical compaction.

## Conclusion

According to the results of this study, warm vertical compaction is the obturation method of preference in oval shape canals as it offers the highest resistance against bacterial leakage.

Injectable gutta-percha technique (obtura II) provides a better resistance to bacterial leakage in comparison to cold lateral technique.

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