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# Comparison of apical sealability of three obturation techniques (an in vitro study)

**Prof. Dr. Jamal Aziz Mehdi,** B.D.S., M.Sc.
**Dr. Montadher S. Kubba,** B.D.S., M.Sc.

## Abstract

The aim of this study was to evaluate the sealing ability and the time required to complete obturationof three different obturation techniques.The palatal roots of sixty maxillary first molar teeth were selectedfor this study. The root canals prepared using ProFile rotary instruments to an apical dimension of size 40 (.06 taper). Thespecimens were then randomly divided into 3 experimental groups (20 sample of each) and filled with gutta-percha and sealer byusing either cold lateral compaction, Thermafil, or the Easy & Quick Master system.For the first parameter(Time of obturation), the results showed that Thermafil technique required the least time to complete obturation and it was significantly lower than other twogroups.The second measurement (Microleakage) showed that the lateral condensation technique leaked apically and significantly higher than other test groups, while the Thermafil group exhibited the least value of apical microleakage.

**Key wards: apical leakage, dye penetration, Easy & quick master obturator, root canal obturation.**

## Introduction

Besides proper cleaning and shaping of the root canal, the complete and hermetic obturation of the root canal system is a major objective in root-canal treatment[(1)]. Sealing generally includes the use of a semisolid material (gutta-percha) and sealing cement; the gutta-percha serves as the core-filling material, whereas the root canal sealer is required to adhere to dentin and fill the discrepancies between the core-filling material and the dentinal walls[(2)].

Work reported by Ingle et al., in the so-called Washington study suggested that apical percolation of periradicular exudate into the incompletely filled root canal accounted for approximately 60% of endodontic failure. As a result of these findings, many changes in the techniques of biomechanical preparation and root canal obturation have been made on the basis of apical leakage studies[(3)]. Lateral compaction of gutta-percha is one of the most widely used techniques and often has been used as the standard to which the sealing ability of new filling techniques or materials are compared. Advantages of the lateral compaction technique are relative, ease of use and the controlled placement of the filling material. Disadvantages include the potential lack of homogeneity of the gutta-percha mass (i.e., individual cones being surrounded by sealer), a high percentage of sealer in the apical

portion of the canal, and poor adaptation to root canal walls[4].

To overcome these disadvantages, warm vertical compaction of gutta-percha has been introduced, in which technique-softened gutta-percha is molded into the intricacies of the root canal system and a more homogeneous mass of gutta-percha is the result. Vertical compaction technique, however, may be more difficult and time consuming, especially for the incremental backfilling of the coronal part of the root canal. Some attempts to simplify the technique have been introduced, such as the "continuous wave of condensation" or System B technique for the down pack and the use of injectable gutta-percha for backfilling the canal after an apical seal is obtained with the down pack[5].Carried-based techniques, best represented by Thermafil, have been introduced to make root canal filling easier and less time consuming, with a clinical outcome apparently similar to cold lateral condensation[6].

The Easy & Quick Master system, is a relatively new introduction to the endodontic armamentarium for root canal filling, which is used in a similar manner as the System B technique. The system consists of a control unit with a pen-grip device holding a heating tip, as well as a gutta-percha injection gun (akin to Obtura II). To date, little reports of the sealing property of this method of delivering the gutta-percha is available to support its use as an alternative to the System B and Obtura II combination[7].

## Materials and Methods

Sixty freshly extracted maxillary first molars teeth with straight palatal root canal and mature apices were selected for this study according to specific criteria. After extraction, all teeth were stored in thymol crystal at room temperature. Any soft tissue remnants on the root surface were removed with sharp periodontal curette and the root surface were examined under a stereomicroscope to ensure the absence of cracks or fracture[8].

Using a diamond disc bur with straight hand piece at speed of 3000 rpm and water coolant the palatal roots of teeth were sectioned perpendicular to the long axis of the root which was marked using marker pin to facilitate straight line access for canal instrumentation and filling procedure and to get 10mm length. The pulpal tissue was removed by using barbed broach and the exact location of the apical foramen and the patency of the canals were verified by insertion of a No.10 K-file into the canal and advancing until it was visualized at the apical foramen[9].

The canals were prepared with crown-down technique using Profile taper rotary files to an apical dimension of size 40 (.06 taper)according to the manual instructions.A 10 ml of 2.5% of sodiumhypochlorite (NaOCL) was used for irrigation during instrumentation then 5ml of 17% EDTA rinses were used after instrumentation and left in the canal for 1 minute to remove the smear layer followed by 10 ml of 2.5% sodium hypochlorite. The roots were dried with paper point[7].

### Root canal filling

The roots were randomly distributed into 3 experimental (n=20). Each group had 2 negative and two positive controlled roots. The rootcanals were filled using one of the 3 techniques describedbelow. The root canal sealer used in this study was the Endofill sealer.

**Group 1** consisted of 20 roots, for which the cold lateralcompaction technique was used. Briefly, a standard size40 gutta-percha

master cone (DENTSPLY-Maillefer) wasfitted to the working length and exhibited a "tug back"sensation. The sealer was mixed according to the manufacturer'sinstructions and introduced into the canal byusing a size 35 K-file operated by hand in a counterclockwiserotation. The tip of the master cone was coated withthe sealer and seated into position. Lateral compactionwas accomplished using a size 20 finger spreader (DENTSPLY-Maillefer) that was able to reach within 1 mm of the working length Accessory gutta-percha cones were added and similarlycompacted. The process wascompleted when the spreader could not penetrate morethan 3 mm into the canal. Finally, excess gutta-percha wasremoved with a hot plugger at the orifice[7].

**Group 2** was filled using a Thermafil obturator (size 40with plastic core; DENTSPLY-Maillefer). A thin layer ofsealer was introduced into the root canal, avoiding apicalpooling. The preheated Thermafil obturator was then insertedinto the root canal to the apical stop in one steadymotion. After cooling, the excess gutta-percha and handlewere removed at the orifice by using a low-speedinverted-cone bur. Finally, any gutta-percha was compactedvertically with a plugger toward the orifice.

**Canals in group 3** were filled using the E & Q mastersystem (Meta Dental Corp.) according to the manufacturer'sinstructions. Briefly, a heating tip in the pen-griphandpiece was selected to fit, without binding, 4-mmshort of the working length. A 0.06-tapered gutta-perchacone was selected; the sealer was applied; and thecone was inserted into the root canal. Theheating tip was activated to a setting of 200°C, and thecoronal excess of the gutta-percha cone was seared offat the orifice. The activated tip was then inserted in aslow, steady motion into the canal to a depth 4-mmshort of the working length and was maintained therefor 3 to 4 seconds. The tip was allowed to cool for 10seconds and removed after a single burst of heat wasapplied for about 1 second. Then compacted vertically with prefitted plugger. The canal was then backfilled by using theE & Q gun until the canal was completely filled withgutta-percha. This technique was similar to the continuouswave of condensation technique[5].

## Time study

The time for canal obturation was recorded in seconds using a stop watch. After application of sealer the recording of time started. For Group 1 CLC the time was recorded when complete compaction of the gutta-percha vertically by the finger plugger at the end of the obturation process press stop for the stop watch and record the time. For Group 2 (Thermafil) After application of the sealer for the canals the time was recorded when the plastic handle of Thermafil obturator was seared off by high speed bur. While for Group 3 (E&Q Master obturator) recording of time was done immediately after compacting the increments of gutta-percha with prefitted plugger when complete backfilling of the coronal third.

## Linear dye penetration method

The apical sealing ability of Groups 1, 2and 3 was evaluatedusing a linear dye penetration method. All the experimental root surfacesexcept the apical 2 mm were covered with one layer of nail varnish and two coats of sticky wax. Theteeth were then

immersed in India ink (Pelikan, Hannover,Germany) for 7 days[10]. After removal from the dye,the teeth were washed under running tap water andThe sticky wax was scraped from the root surface with a lacron carver and washed again under running water[10]. Demineralization and clearing process was completedas described by (Al-Hashimi)[11]. The teeth were demineralized in 5 % nitric acid solution and dehydrated in99-100% ethyl alcohol for 3 days with daily change of alcohol. The clearing process wascompleted by immersing the teeth in methyl salicylatesolution.The extent of dye penetration was measured by two observers using a stereomicroscope (Kruss, Germany)in millimetres. The measurements were made from themost apical extent of gutta-percha to the most coronalextent of dye penetration. The data were analysed statisticallyusing ANOVA and Student t-test[12].

## Results

For the microleakage parameter the results of this study showed that group 2 (Thermafil obturation system) have the lowest mean value of dye penetration (0.45) while the highest mean value of dye penetration was for group 1 (cold lateral condensation) (0.590). The rest value for the 3rd group (E&Q system) was fluctuation between these values. AVOVA test showed that there is a significant difference among group, while student t-test showed that there is a highly significant difference between group 1&2 while there is no significant difference between 1&3 and for 2&3.

For the time parameter the results of this in vitro study showed that group 2 (Thermafil obturation system) have the lowest mean value of time required to complete obturation (90.750) while the highest mean value of time required was for group 1 (cold lateral condensation) (126.938). The rest value for the 3rd group (E&Q system) was almost equal to group 1. AVOVA test showed that there is a significant difference among tested group, while student t-test showed shows that there is a highly significant difference between group 1&2 and between 2&3 while there is no significant difference between 1&3.

## Discussion

In the present study, the apical sealing abilities and the time required to complete obturation of Thermafil,CLC and E&Q master techniques were compared. For the microleakage, thelowest mean leakage values were observed for Thermafiland the highest mean leakage values were observed for CLC groups.The higher leakage of lateral compaction heremight be due to several factors. The addition of accessorygutta-percha cones could create a greater amount of voidsbetween these cones. The cold, solid gutta-percha conesfailed to adapt to the root canal wall and to each othereasily. In contrast, thermoplasticized gutta-percha in groups 2, and 3 could penetrate the intricacies of theroot canal system and achieve better sealing. Anotherpossible factor may be the relative amount of sealer thatmight have shrunk or partially dissolved in time[7]. Greene et al. have compared several filling techniques and foundthat the specimens with the least amount of leakage usuallyhave minimal amounts of sealer in the canal[13].

The lowest mean value for the Thermafil system may be related to several factors such as gutta-percha-filled area (GPFA). This approach means the area of the whole canal, gutta-percha, sealer-filled area and

voids were measured in cross-sections, and the percentage of filled area. This analysis suggest that some sealer are soluable and their dissolution may trigger an increase in leakage along the root filling over time. So that keeping the sealer restricted to a thin layer distributed uniformly around a solid mass of gutta-percha may improve the long-term seal provided by the root canal filling[14].Another factor was the presence of the plastic carrier in Thermafil that could also act as plunger, which effectively forces the thermoplasticized gutta-percha into the lateral walls of the canal. This condensation of the thermoplasticized gutta-percha into the patent dentinal tubules might also reduce the volume of gutta-percha undergoing setting contraction and contributed to the superior seal exhibited by the Thermafil Group[15].

Alpha-phase gutta-percha has low melting temperature and good adhesiveness, whereas beta-phase gutta-percha has higher melting point, and no properties of adhesion. Thermafil obturators are flexible plastic carriers coated with alpha-phase gutta-percha. Hence, the potential for the shrinkage of the thermoplasticized gutta-percha as used in Thermafil should be lesserthan that of other thermoplasticized techniques[15].

The least leakage observed with Thermafil group may be realted to its ability in filling the main canal as well as lateral canals because the thermoplasticized gutta-percha could penetrate the intricacies of the root canal system and achieve better sealing[7][16].

For the time parameter, results showed that Thermafil group required the minimum value to complete obturation among the rested groups and this may be related to simplicity of the technique and the least of the necessary steps to finish the obturation. After the oven time ends, only the steady motion for the core inside the canal and cutting the plastic core does remain. In comparison with the other techniques, in E&Q obturation method there was many steps to complete the obturation. For instance, in E&Q there are two parts of the technique, first is the heating pen step and the second one is the gun step. After each of which a vertical condensation step by using cold finger plugger is required to finish the obturation.

On the other hand, lateral condensation require much more steps of lateral condensation to get it done by using ISO standardized cones and finger spreader to condense the accessary cones. Where in the lateral condensation group we need to use finger spreader after each accessory gutta-percha point and this makes those techniques consuming much more time than the Thermafil required and this may explain the results that obtained with this study.

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Table (1): Descriptive statistics of analysis for experimental groups, (microleakage).

| Group | N | Mean | S.D. | S.E. | Min. | Max. |
|---|---|---|---|---|---|---|
| 1 | 16 | 0.590 | 0.112 | 0.028 | 0.45 | 0.75 |
| 2 | 16 | 0.45 | 0.079 | 0.019 | 0.35 | 0.55 |
| 3 | 16 | 0.512 | 0.114 | 0.028 | 0.4 | 0.75 |

Table (2) ANOVA test among groups, (microleakage).

| Source of variation | Sum of Squares | DF | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | 0.158854 | 2 | 0.079427 | 7.390 | 0.0016 ** |
| Within Groups | 0.483594 | 45 | 0.010747 | | |
| Total | 0.642448 | 47 | | | |
| ** | High significant | | | | |

Table (3) Student t-test between groups, (microleakage).

| Groups | t-test | P.value | Sig. |
|---|---|---|---|
| 1&2 | 4.07 | 0.000 | HS. |
| 1&3 | 1.94 | 0.062 | NS |
| 2&3 | -1.79 | 0.084 | NS |

Table (4): Descriptive statistics of analysis for experimental groups, (Time).

| Group | N | Mean | S.D. | S.E. | Min. | Max. |
|---|---|---|---|---|---|---|
| 1 | 16 | 126.938 | 11.108 | 2.777 | 113 | 148 |
| 2 | 16 | 90.750 | 4.973 | 1.243 | 82 | 97 |
| 3 | 16 | 122.688 | 6.322 | 1.580 | 112 | 135 |

Table (5) ANOVA test among groups, (time).

| Source of variation | Sum of Squares | DF | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | 12520.54 | 2 | 6260.271 | 99.849 | 0.000 *** |
| Within Groups | 2821.375 | 45 | 62.697 | | |
| Total | 15341.92 | 47 | | | |
| *** | Very High significant | | | | |

Table (6) Student t-test between groups, (time).

| Groups | t-test | P.value | Sig. |
|---|---|---|---|
| 1&2 | 11.893 | 0.000 | HS. |
| 1&3 | 1.33 | 0.194 | NS. |
| 2&3 | -15.883 | 0.000 | HS. |

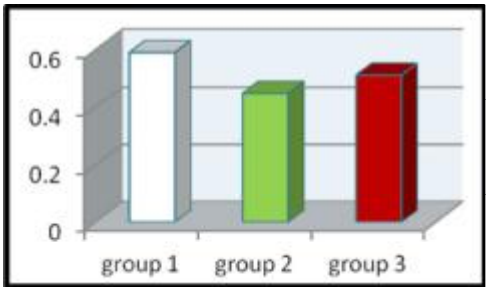


**Fig (1) Bar chart showing the mean value of apical microleakage of obturation groups.**

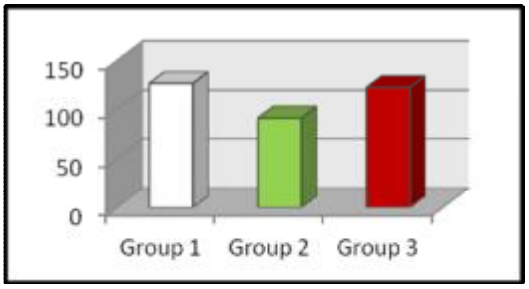


**Fig (2) Bar chart showing the mean value for the time required to complete obturation.**