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IN-VITRO EVALUATION OF APICAL MICRO LEAKAGE OF THERMAFIL AND OBTURA II HEATED GUTTA PERCHA IN COMPARISON WITH COLD LATERAL CONDENSATION USING FLUID FILTRATION SYSTEM

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ABSTRACT

This study evaluated the apical sealing ability of root canals obturated with Thermafil and Obtura II heated gutta percha system in comparison with conventional cold lateral condensation by using Fluid filtration system. 55 extracted human mandibular first premolars were collected and these teeth were randomly divided into three groups of 15 specimens each. (Group I - Cold lateral condensation, Group II – Thermafil, Group III - Obtura II heated gutta percha system). Profile Ni-Ti instruments were standardized to perform biomechanical preparation in all the groups. Top seal, an epoxy based sealant was employed as the common sealant. The group I comprising of Cold lateral condensation leaked the most in comparison with the other test groups, which was followed by group III (Obtura II) with moderate leakage and group II (Thermafil) with least micro leakage.

INTRODUCTION

The three dimensional Obturation of the root canal system is widely accepted as a key factor for successful endodontic therapy. Schilder states, " The objective of root canal procedures should be the total three dimensional filling of the root canal and all accessory canals." A three-dimensional well-fitted root canal prevents percolation and micro leakage of periapical exudates into the root canal space, prevents re-infection, and creates a favorable biological environment for healing to take place.

Gutta-percha is the most commonly used root canal Obturation material. Its physical properties have made possible several different Obturation techniques. The cold lateral condensation of gutta-percha is one of the most commonly used techniques in endodontics. However, its ability to replicate the internal surface of root canal has been questioned. Voids, incomplete fusion of gutta-percha cones, and lack of surface adaptation have been questioned. Recent advances in technology have led to development and implementation of many gutta-percha obturating systems.

Obtura II, a thermoplasticized inject able obturation technique was introduced by Yee et at in 1977 to improve the homogenicity and surface adaptation of the gutta percha and have been proved to significantly better than lateral

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condensation in replicating root canal[1]. Control of the apical extrusion of the softened gutta percha has been a major problem with these techniques[2].

In 1978, Johnson introduced a technique in which alpha phase gutta-percha was placed on a metal carrier, heated and used to obturate the root canal. This system is commercially available as Thermafil Endodontic obturators [Tulsa Dental Products, Tulsa]. Currently there are three different types of Thermafil obturators, the differences based, on the carrier material for the gutta percha. Stainless steel, titanium and plastic carriers are coated with alpha phase gutta percha and become part of the final obturation.

In the past, leakage of various root canal filling materials have been measured by penetration of dyes, isotopes, microorganisms, or electro-chemical means. All of these techniques have been shown to have a variety of shortcomings. Derkson et al[3] developed a fluid filtration technique to measure micro leakage around coronal restorations. This technique was adapted by Wu et al [4], to measure microleakage of root end fillings. They described this technique as being capable of quantitatively measuring volumetric micro leakage. Hence, the objective of this study is to evaluate the apical micro leakage of Thermafil and Obtura II in comparison with Cold lateral condensation using fluid filtration system.

MATERIALS AND METHODS

Fifty-five extracted human mandibular first premolars were collected and stored in deionised water with thymol. Before the experiment, the teeth were placed in 5.25% sodium hypochlorite for 8 hours to remove the debris. Soft periodontal tissue was removed with hand curettes. With the help of a diamond disk with air- water spray coolant, the crowns of each tooth are removed at cemento-dentinal junction. After the pulp tissue is removed with a barbed broach, a K-file ISO # 010 is introduced into the root canal until it could be seen at the apical foramen. One millimeter is subtracted from this length to determine the working length. The root canals are prepared up to the cemento-dentinal junction using profile nickel-titanium instruments. After each instrument change, the canals are irrigated with 2ml flush of each of irrigant. The irrigants used are 5.25% of sodium hypochlorite and 17% of EDTA, which are delivered through a 25-guage needle, which was placed as for as possible into the canal without allowing the needle to bind with the canal walls.

In the present study, the teeth are randomly divided into three groups of 15 specimens each as following:

GROUP I - The specimens are obturated with cold lateral Condensation technique.

GROUP II - The specimens are obturated with Thermafil

GROUPS III- The specimens are obturated with Obtura II.

CONTROL GROUPS: The remaining 10 specimens were randomly divided into 2 groups of five, each to serve as the negative and positive control.

Positive control - Specimens are instrumented and left unobturated.

Negative control - Specimens are

instrumented and filled with cyanoacrylate cement. The roots are then coated with two layers of nail polish and allowed to dry, to ensure that there was no leak or fluid movement anywhere within the device.

After Obturation, all the teeth are stored for 24 hours at 37 degree centigrade in 100% humidity to allow setting of the sealer.

FIGURE 1. FLUID FILTRATION SYSTEM

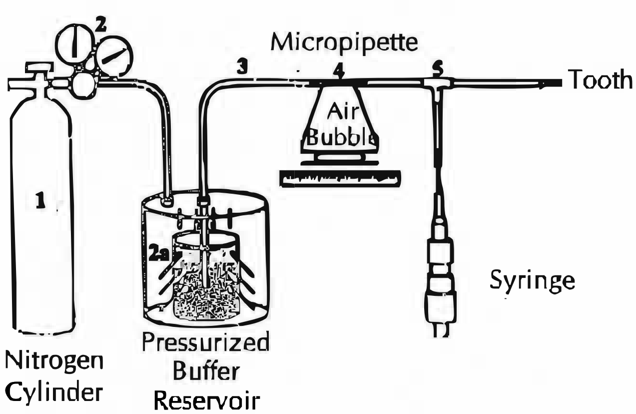

TABLE 1

Number Of Teeth	GROUP I Cold Lateral Condensation mm /hr- fil/min		GROUP II Thermafil mm/hr-fil/min		GROUP III Obtura II mm /hr- fil/min	
1.	26	0.34	9	0.11	18	0.23
2.	30	0.39	11	0.14	15	0.19
3.	27	0.35	7	0.09	16	0.20
4.	28	0.36	7	0.09	16	0.20
5.	26	0.34	8	0.10	18	0.23
6.	28	0.36	9	0.11	17	0.22
7.	25	0.32	9	0.11	15	0.19
8.	26	0.34	7	0.09	18	0.23
9.	27	0.35	8	0.10	10	0.20
10.	28	0.36	7	0.09	17	0.22
11.	27	0.35	8	0.10	17	0.22
12.	26	0.34	9	0.11	17	0.22
13	27	0.35	8	0.10	18	0.23
14.	30	0.39	8	0.10	17	0.22
15.	27	0.35	9	0.11	15	0.19

Micro leakage values expressed in micro liters per minute.

TABLE 2

GROUP	N	MEAN	STANDARD DEVIATION
I	15	0.35	0.02
II	15	0.10	0.01
III	15	0.21	0.02

Group I-Cold Lateral Condensation

The canals of Group I were obturated with cold laterally condensed gutta percha. A standardized ISO NO. 30 master cone gutta percha was trail fitted up to the working length .Top epoxy resin sealant was then mixed according to manufacturer's instructions and using a paper point the sealer was introduced into the entire length of the canal. The apical part of the master gutta-percha cone was coated with the sealer and placed into the canal. The master cone was laterally condensed by inserting a finger spreader between it and the root canal wall. The spreader was inserted to a point 1 mm short of the working length. The spreader was rotated to 180° several times before disengaging it from the canal. The void created by the spreader was filled by condensing an auxiliary gutta-percha point. The procedure was repeated until gutta-percha points could not be introduced more than 3 mm into the root canal. The excess gutta-percha was then removed with a hot plastic instrument and the remainder was condensed vertically with a plugger

Group II- Thermafil

The 15 specimens in-group II are obturated with the Thermafil plastic obturators. After completion of instrumentation with profile Ni-Ti instruments, a size 30 Thermafil carrier was employed to check whether the carrier reached the full length with out being forced by rotation and twisting. Once the fit is verified, a rubber stop marker is adjusted according to the working length on the shaft of the Thermafil obturators. Then each canal was coated with a thin layer of Top seal sealant with the help of the paper point. Therma-prep oven was pre heated before obturators are heated, then sizeSO Thermafil obturator was placed in the Therma-prep oven. According *to manufacturer's*, instructions a timer was used to ensure correct heating time. After removing the obturator from the oven, firm apical pressure is used to insert the Thermafil obturator into the canal to the previously marked working length with stop marker. After radiographic verification, the carrier shaft is severed with inverted cone bur at the canal orifice. Then a small condenser lubricated with Vaseline is used to condense vertically the gutta percha around the shaft.

Group III-Obtura II Heated Gutta-percha System

The 15 specimens in-group III are obturated with the Obtura II heated gutta percha system. The canals were coated with very little quantity of Top seal sealant, because excessive sealer causes pooling. The gutta-percha pellets were loaded into the syringe and the temperature control on the unit was adjusted to 160 degrees. The 23-guage-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.

FLUID FILTERATION SYSTEM

Fluid filteration system is shown in Figure 1.A pressurized nitrogen cylinder is connected to a pressurized buffer reservoir, which is filled with saline solution. The exit end of this reservoir is connected to a silicone tube, which is 3 mm in diameter. This silicone tube is connected to a micropipette with an inner diameter of 1mm. The other end of the micropipette is connected to a silicone tube, which in turn is connected to a T tube, to which a syringe and silicone tube were connected. At the end of this silicone tube the tooth is inserted in an apical direction and affixed with cyanoacrylate cement applied only on the outer surface of the tooth, so that the orifice is not blocked with cement.

After the system is assembled, a syringe which is filled with Indian ink is used to introduce an air bubble into the system to highlight the movement of the air bubble. After introducing the air bubble this end of the silicone tube is clamped with artery clamps to make it leak proof. A 15-psi pressure[5] was applied to the saline reservoir and the movement of the air bubble signifying fluid movement toward the root sample is recorded. This micro leakage is recorded in millimeters for a period of 1 hour[6]. The millimeter per hour linear recordings is converted into micro liters per minute. The results are expressed in μl/min for three experimental groups.

RESULTS

The micro leakage values for group I, II and III are shown in the table 1. Results of table-1 showed that, the Group I (Cold lateral condensation) showed the highest leakage value, which was followed by Group III (Obtura II) with moderate leakage and Group II (Thermafil) with least leakage. The mean and standard deviation of the variable micro leakage for different study groups is given in the table 2.

One - way ANOVA was used to calculate the P - value, and multiple range tests by Tukey - HSD procedure was employed to identify the significant groups at 5% level. Statistically, the mean value in Group I (Cold lateral condensation) (0.35 ± 0.02) is significantly higher than Group II (Thermafil) (0.10 ± 0.01) and Group III (Obtura II)(0.21 ± 0.02) ($P < 0.05$).

DISCUSSION

Cleaning and shaping is undoubtedly of paramount importance in successful endodontic treatment. However, this does not negate the importance of the quality of obturation. This is validated by the fact that nearly 60% of failures in endodontics can be attributed to incomplete obturation of the root canal[7]. Hence, a three - dimensional obturation is critical for endodontic success.

Irrespective of the obturation technique employed, micro leakage remains to be the most crucial cause of endodontic failure. Micro leakage is defined as the passage of bacteria, fluids, and chemical substances between the root structure and filling material of any type. This occurs because of microscopic gaps at the interface of the filling material and the tooth. Microleakage in the root canals is complicated as many variables may contribute, such as root filling technique and chemical properties of the sealer and the infectious state of the canal.

Nicholls[8] stated that poor seal may lead to voids in the apical region of the canal where stagnation of tissue fluid can occur. The subsequent proteolysis and irritation can result in persistence of existing periapical lesion or formation of fresh lesions. Traditionally, clinical emphasis has been on the apical sealing of the root canal obturation. Thus, most leakage experiments[9,10] have assessed the quality of apical seal by dipping the root tip into a die solution and thus measuring penetration in a apico-coronal direction.

Traditionally various methods have been used to assess the quality of root canal seal by micro leakage suck as dye penetration test, bacterial leakage test, radio tracer penetration test and vacuum studies, each of these methods have their inherent draw backs. Hence in an attempt to over come these draw backs, Derkson et al[3] deviced fluid filtration technique as an objective method to assess micro leakage. This fluid filtration technique[11,12,13] allows the investigator to measure quantitatively the volume of the leakage. Zakarian et al considered the measurement of the volume to be more indicative of true leakage than simply an indication that it occurs.

Fluid filtration studies present several advantages over the traditional micro leakage studies.[14] The samples are not destroyed, allowing repeated measurements over a period of time. Traditional method of sectioning of the samples are associated with loss of some of the tooth structure due to thickness of cutting blade and the sectioning process, thus affecting the accuracy of the measurements of the dye penetration [15]. In the chosen technique no tracer is needed with the related problem of molecular size and affinity for dentin and no intricate materials are required as in the bacterial penetration studies or radioactive tracer studies. There is no modification of seal in this technique because the measurements are made directly after filling without dipping the roots in acids, alcohol or methyl salicylate. This technique also avoids problems caused by entrapped air or fluids without using high pressures employed in vacuum studies. The results are very accurate because even very small volumes can be recorded. Thus, by using this technique, a better standardization of the methodology is achieved.

In Statistical analysis group II (Thermafil) presented a mean micro leakage of 0.10 μl/min, which was the least among the three groups, followed by group III (Obtura II) and group I (lateral condensation) with a mean micro leakage of 0.21 μl/min and 0.35 μl/min respectively. In the positive control group, the fluid flow was rapid and continuous, whereas in the negative control group no leakage was encountered, thus indicating that this fluid filtration system was accurate.

A number of studies evaluated Thermafil obturators and found that it proved a better seal than lateral condensation[16,17,18] . The superior sealing ability of Thermafil can be attributed to its ability in filling main canal as well as lateral canals. It was also found that there were fewer voids in the apical third of the obturation when compared to that of lateral condensation.

However, in an other dye penetration study done by Ravanshad and Torabinajad[19] comparing Thermafil and cold lateral condensation, results showed that Thermafil group leaked more than the cold lateral condensation. A ZnO-eugenol based sealant, Roth's root canal sealer was employed in Ravanshad's study, and that could be the reason for more micro leakage. However, Dalat and Spanberg [20] found that Thermafil seals best with an epoxy resin based sealant. Hence, Top seal, an epoxy-based sealant was employed in the present study. This factor could have been one of the reasons for the superior seal exhibited by Thermafil.

The irrigants used in Ravanshads study[19] were not mentioned, while in this study, 5.25% of sodium hypochlorite and 17% EDTA were employed as irrigants for smear layer removal. The absence of smear layer could have improved the seal at the sealant-dentinal wall interface, as it has been proved that Thermafil gives a better seal when the smear layer is removed [21,22]. This improved seal could also have been another reason for minimal leakage exhibited by the Thermafil group.

In the present study, Obtura II group leaked more (0.21ul/min) than the Thermafil group (0.10 ul/ min). Shrinkage of thermoplasticized gutta-percha occurs during it's cooling to 37° C[23]. 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. This setting contraction has to be compensated by the sealant being employed[24]. Thermafil obturators are flexible plastic carriers coated with alpha-phase gutta-percha while Obtura II contains beta phase gutta percha. Hence, the potential for the shrinkage of the thermoplasticized gutta-percha as used in Thermafil should be lesser than that of Obtura II. Moreover, in the Thermafil system the majority of the canal space is filled with the plastic core there by reducing the volume of gutta-percha undergoing setting contraction.

This reduction in shrinkage could have increased the seal at the gutta-percha- sealant interface, there by contributing to decreased leakage. This would have been one of the reasons for Thermafil to leak less than the other thermoplasticized technique assessed, namely Obtura II.

The plastic carrier in Thermafil 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 have contributed to the superior seal exhibited by the Thermafil Group.

The group I comprising of cold lateral condensation leaked the most (0.35μl/min) in comparison to the other test groups, with the difference being statistically significant ($p<0.05$). The time tested lateral condensation technique is most widely accepted due to its advantages like long-term use, predictability, controlled placement of materials and relative ease of use. However, this technique produces many irregularities in the final mass of gutta-percha. It also does not reproduce canal irregularities and there is an inadequate dispersion of the sealer leading to the formation of voids in and around the gutta-percha points. Therefore this drawback, may have contributed to the high leakage score seen in this group.

This study was done by employing materials that were manipulated strictly to the manufacturer's instructions. The results indicate that, a combination of Profile Ni-Ti instrumentation with the Thermafil Obturation leaked the least by using the fluid filtration technique. Hence, Thermafil Obturation technique can be advocated as an efficient obturation system for achieving optimal and predictable success in endodontic therapy.

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