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ORIGINAL RESEARCH

In vitro Comparative Study of the Microbial Leakage of One-step, Thermafil and Lateral Condensation Techniques

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ABSTRACT

Aim: To compare the apical seal of lateral condensation technique, thermafil and one-step by using this model.

Materials and methods: A two-chamber bacterial microleakage model using *E. faecalis* as microbial marker was used for evaluation of the leakage. Bacterial penetration was monitored over a 60-day period. Leakage was recorded when turbidity was observed in the lower chamber.

Results: After comparing the bacterial penetration values, total penetration was observed 45% in lateral condensation technique, 80% in thermafil and 75% in one-step. There was no significant difference between groups after 60 days; however, the microleakage in lateral condensation group was seen later than one-step and thermafil.

Conclusion: Thermafil and one-step obturator can be advocated as effective obturation techniques for achieving predictable success in endodontic therapy.

Clinical significance: Thermafil and one-step obturator are suitable devices for obturation.

Keywords: Microbial leakage study, Lateral condensation, One-step, Thermafil.

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INTRODUCTION

Optimal filling of the root canals in three-dimensions has paramount importance in preventing reinfection of the root canal space.[1] Nearly, 60% of all endodontic failures have been attributed to incomplete obturation of the canal system.[2] Attempts were made to develop filling materials and techniques to increase the quality of the canal seal. Although numerous materials have been used for obturation, the most commonly used material is gutta-percha.[3]

Several techniques using gutta-percha have been used in an attempt to achieve a homogenous well-sealing filling. The cold lateral condensation technique is still, one of the most frequently used techniques in endodontics.[4] However, its ability to replicate the internal surface of the root canal has been questioned. Voids, incomplete fusion of gutta-percha cones and lack of surface adaptation have been addressed.[5]

Thermafil (Tulsa dental products) is a technique in which alpha phase gutta-percha is placed on metal carrier, heated and used to obturate the canal. Also, one-step is an obturating technique that recently introduced into the market and is similar to thermafil, but is approximately 20% less expensive.[3]

Although the use of dyes, radioisotopes, fluid filtration, bacteria and endotoxin penetration techniques have been used to evaluate the seal of endodontic material[1,5] but the bacterial leakage model has been advocated as a more clinically relevant model.[1,6,7] Thus, the purpose of this study was to compare the apical seal of lateral condensation technique, thermafil and one-step by using bacterial leakage model.

MATERIALS AND METHODS

Sixty-eight human maxillary lateral incisors were used in this study. The teeth were get rid of attach tissue and calculus and then immersed in 5.25% sodium hypochlorite for 24 hours.

A single operator performed the root canal preparation and filling. To insure that all specimens were of the same length, they were resected 14 mm from the apex using water cooled diamond bur.

The canals were accessed and the working length was determined by inserting a #10 K-file in the canal until it was just visible at the apical foramen, then subtracting 1 mm. Apical patency was maintained throughout instrumentation using #15 K-file. The canals were instrumented using crown-down technique with rotary ProTaper instruments (Dentsply Maillefer, Switzerland) to a master apical file size of finishing file No. 3 (F3) and were irrigated between files with 2 ml of 5.25% sodium hypochlorite. Following instrumentation, the smear layer was removed with 17% EDTA, followed by 5.25% sodium hypochlorite. The canal was then dried with sterile paper points.

The roots were randomly divided into three groups (n = 20). Each group was filled using one of the three techniques described below. The sealer used in this study was AH26 (Dentsply DeTrey, Germany).

In group 1, cold lateral condensation technique was used. A standard #35 gutta-percha master cone was fitted to the working length. The master cone was coated with the sealer and seated into the position. Accessory gutta-percha cones were added and similarly compacted. The process was completed when the spreader could not penetrate into the coronal third of the canal. Finally, excess gutta-percha was removed with a heat carrier at the orifice.

In group 2, canals were filled by using #35 thermafil system (Dentsply Maillefer, Switzerland). A thin layer of sealer was introduced into the canal, avoiding apical pooling. The thermafil obturator heated in ThermaPrep Plus heating system and then was inserted into the canal to the apical stop in one steady motion. After cooling, the excess gutta-percha and handle were removed at the orifice by using a low-speed inverted-cone bur.

In group 3, canals were filled by using one-step obturator according to the manufacture's instructions. One-step #35 heated in one-step oven and then was inserted into the canal to the apical stop. The excess gutta-percha and core carrier were removed at orifice by twisting one-step tweezer.

Four teeth that were instrumented but not obturated were used as positive controls to demonstrate bacterial leakage through the entire length of the canal. The negative control teeth (4 teeth) were instrumented and obturated and sealed externally with two layers of nail polish except coronal access.

After filling, all roots were examined to confirm an absence of any vertical root fracture. The roots were then stored in 100% relative humidity at 37ºC for 2 weeks to allow the sealer to set completely.

The roots of 60 teeth (in all 3 groups) were sealed with two layers of colored nail polish, except for the apical 3 mm around the apical foramen. The tapered end of 2 ml Eppendrof plastic tubes was cut and obturated roots were inserted into the tubes until the roots protruded through the end. The junction between each tube and root was sealed with sticky wax to prevent leakage of the connection. Externally junction between each tube and root sealed with twin glue. These prepared Eppendrof tubes could be put in 30 ml glass tubes (Zimax 100 × 12). So that 3 mm of the root apex was submerged in Muller-Hinton Broth. The junction between the Eppendrof tube and glass tube was sealed with parafilm tape. The system was sterilized by gamma radiation with 40 kilo-gray dose. To insure sterilization, the whole system was incubated at 37ºC for 3 days. Any test apparatus that showed signs of turbidity in Muller-Hinton Broth was discarded.

E. faecalis organism was cultured at 37ºC for 24 hours in Muller-Hinton Broth. The bacterial suspension was adjusted to insure that the amount of bacteria was 10^9 CFU/ml. An inoculum of *E. faecalis* (1 ml, 10^9 CFU) was injected into the tubes using a micropipette. The tubes were incubated at 37ºC for 60 days. An inoculum of *E. faecalis* was changed with fresh inoculum every 3 days. The color of the Muller-Hinton Broth was checked every day for turbidity, which was taken as indicator of bacterial penetration. To confirm the purity of *E. faecalis* in the Muller-Hinton Broth, a sample was taken in these tubes and cultivated.

Statistical analysis was done and findings were analyzed by Chi-square test with SPSS software (v.13) (SPSS Inc, Chicago, IL, US). p-value < 0.05 was considered significant.

RESULTS

All positive controls demonstrated bacterial penetration after one day, whereas all specimens of the negative control were not penetrated for the entire observation period. The bacterial penetration data are showed in Table 1.

After 60 days of comparing the bacterial penetration values, total penetration was observed in 45% of lateral condensation group, 80% of thermafil group, and 75% of one-step group. On the other hand, the lowest penetration was observed in lateral condensation group but statistical analysis indicated no significant differences between groups (p > 0.05).

The Kaplan-Meier method was used to estimate survival curves for each groups and indicated occurance of time at which bacterial leakage first become evident [log Rank (Mantle-Cox) = 0.018], the lateral condensation groups exhibited microbial leakage later than other groups (Fig. 1).

DISCUSSION

In the present study, the microleakage sealing abilities of lateral condensation technique, thermafil and one-step were compared using inoculation of *E. faecalis* during 60 days.

In the absence of an intact coronal seal, recontamination of the entire length of filled canals by bacterial or their by products may occur.[1] The model that used in this study was two-chamber bacterial microleakage model that described by Torabinejad et al.[8]

Bacterial leakage model is commonly used and appears most clinically relevant. *E. faecalis* was chosen because is part of normal flora in human and are frequently found in mixed infections.[3,7]

In this study, maxillary lateral teeth were just chosen because root shape may be an important factor in leakage of carrier-based obturation techniques. Also in our research 5.25% sodium hypochlorite and 17% EDTA were employed as irrigation 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 give a better seal when the smear layer is removed.[9] Desirable properties of AH26 sealer might have contributed to the low amount of leakage were observed in core-carrier techniques.[3,7]

The specimens obturated with thermafil and one-step showed the fastest penetration time. An explanation for these might be that the gutta-percha used in warm root canal obturation techniques has been shown to shrink. In addition to this, the other possible reasons are the carrier did not stay centered in the root canal in some specimens and gutta-percha was stripped from the carrier in the apical portion of the canal. Bacteria may thus, penetrate through the remaining space.[7]

Table 1: Bacterial penetration data

	Penetration number (percent)	*No penetration number (percent)*
Lateral condensation (n = 20)	9 (45)	11 (55)
Thermafil (n = 20)	16 (80)	4 (20)
One-step (n = 20)	15 (75)	5 (25)

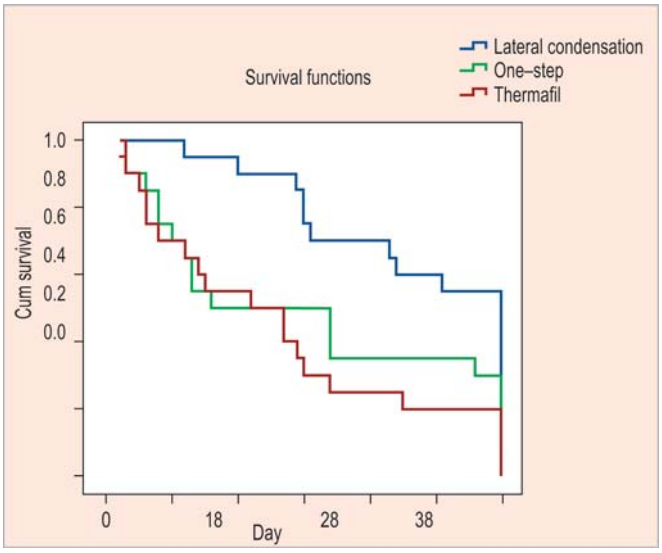

Fig. 1: Survival curve

Our result showed that thermafil and one-step were as effective as lateral condensation to prevent bacterial leakage. Abarca et al,[2] Yucel and Ciftci,[7] and Xu et al[10] have reported the similar results. In this studies reported no significant differences apical sealing ability between thermafil and lateral condensation technique. Lateral condensation technique is the most widely accepted due to its advantages like long-term use, predictability, controlled placement of material and relative ease to use. Also this technique has been found clinically successful (~90%).[11]

A number of studies evaluated thermafil obturators and found it that proved a better seal than lateral condensation.[4,5,10-12] The superior sealing ability of thermafil can be attributed to its ability in filling main canal as well as lateral canals. The plastic carrier in thermafil could also act as plugger, which effectively forces the thermoplasticized gutta-percha into the lateral walls of the canals.[5]

One-step is marketed for use with a technique similar to thermafil. Our results indicated that such method of root canal filling was as effective as thermafil in the sealing of root canal, which is in keeping with the finding of Testarelli et al.[13]

CONCLUSION

A combination of ProTaper instrumentation with thermafil and one-step obturator has microbial leakage similar to lateral condensation technique. Although these two core-carrier techniques can be advocated as an effective obturation technique for achieving optimal and predictable success in endodontic therapy.

CLINICAL SIGNIFICANCE

Thermafil and one-step obturator are suitable devices for obturation.

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