Comparison of Apical Microleakage of Canals Filled with Resilon/Epiphany, Thermafil/Adseal and Gutta Percha/Adseal

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Abstract

Objective: Root canal obturation is an important step in endodontic therapy aiming at achieving a complete three-dimensional seal of the canal and preventing microleakage, reentry or growth of microorganisms in the root canal system. Several techniques and materials are available for root canal filling. Achieving an apical seal is among the most important characteristics of filling materials. This study aimed to compare apical microleakage of three different canal obturation techniques of Thermafil/Adseal, lateral condensation with gutta percha/Adseal and lateral condensation with Resilon/Epiphany using dye penetration method.

Methods: This experimental study was conducted on 51 anterior single-rooted human teeth. The teeth were sterilized, the crowns were cut and canals were prepared using the crown-down technique. The teeth were randomly divided into 3 groups of 15 each for the three techniques and 6 teeth were assigned to positive and negative control groups. The first group roots were filled with Thermafil/Adseal, the second group received gutta percha/Adseal with lateral condensation technique and group 3 teeth roots were filled with Resilon/Epiphany using lateral condensation technique. Microleakage was measured using dye penetration technique. Data were statistically analyzed using ANOVA.

Results: Gutta percha/Adseal had the lowest (6.46(4.27) mm) and Resilon/Epiphany had the highest (13.47(3.03) mm) apical microleakage. Thermafil/Adseal showed higher mean apical microleakage than gutta percha/Adseal (8.43(4.49) mm). Statistical analysis revealed significant differences in apical microleakage among the three groups (p=0.0001).

Conclusion: The results showed that gutta percha/Adseal had the lowest and Resilon/Epiphany had the highest mean apical microleakage. The microleakage of Thermafil/Adseal ranked second.

Key words: Adseal sealer, Apical microleakage, Dye penetration, Resilon/Epiphany, Thermafil gutta percha,

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Introduction:

Root canal obturation is among the most important steps in root canal treatment aiming at obtaining a complete 3D seal of the canal and preventing the reentry and re-growth of microorganisms in the root canal system. Apical microleakage, decomposition of filling materials and formation of toxic substances lead to inflammatory reactions in peri-radicular tissues (1).The three main goals of root canal obturation include elimination of residual bacteria from the root canal system, preventing the entry of fluid derived from the periapical tissues into the canal because it nourishes the bacteria and prevention of coronal microleakage (2). Root sealants are particularly important since it has been reported that 63% of root canal failures are due to apical

leakage attributed to inadequate apical seal (3). Gutta percha is a standard commonly used root canal filling material. It was first introduced by Bowman in 1867 and has optimal properties such as chemical stability, biocompatibility, seal ability, radiopacity and retrievability. However, it does not always have the three afore mentioned ideal characteristics of a root canal filling material (2). Gutta percha does not bond to canal walls. Thus, it cannot completely seal the apex and leaves a gap enabling the leakage of bacteria into the canal. This issue is a weakness point of root canal treatment (4).

In the recent years, efforts have been made to overcome the obstacle of microbial microleakage and drawbacks of gutta percha led to search for new root canal filling materials of better quality. Resilon/Epiphany (R/E) system is among the recently introduced techniques. R/E is a thermoplastic, polymer-based, synthetic material. It comes with its own specific sealer aiming to achieve a chemical bond between the solid core and sealer. Similar to gutta percha, R/E can be removed from the canal in case of retreatment by using solvents. Primary investigations have shown that root canal filling with R/E creates a strong bond between the filling material and dentinal tubules forming a mono-block in which, filling materials, sealer and dentinal tubules form a single solid unit called a mono-block. R/E prevents the penetration and leakage of bacteria into the canal by forming a bond between the dentinal walls and core filling material (5). Resilon can be used in both cold lateral condensation technique and the Thermafil system.

Thermafil system was introduced by Johnson in 1978 (6). Primarily, a carrier system (Thermafil, Dentsply, TulsaDental, Tulsa, OK) was introduced in which a core metal carrier was covered with gutta percha. When the filler is heated, gutta percha softens and is inserted into the canal. This technique gained popularity due to easy application of gutta percha because of the stability of core carrier. Similar to other root canal filling techniques, the quality of cleaning and shaping determines the level of success (6).

In advanced carrier systems, a plastic core carrier covered with gutta percha is used. These systems are also equipped with a heat-generating device that transfers heat and controls temperature. The carrier strengthens its surrounding gutta percha while being flexible. After preparation, the canal is dried and the sealer is applied. Filler of adequate size is heated in a controlled oven environment and inserted into the canal with high pressure to the working length. The carrier is then cut 1 to 2 mm above the canal orifice.

In terms of apical seal, these systems are equal to conventional filling with gutta percha but cannot create a permanent coronal seal. In this system, there is no need to precurve the carriers. If canals are well prepared, carriers easily pass the curve due to their flexibility. By doing so, gutta percha flows into the canal irregularities, the resorption areas and accessory canals (7).

Post space preparation in this technique is done by different instruments. Post space can be prepared immediately or with a delay after root canal obturation without affecting the apical seal using Thermacut burs (Tulsa Dental Products, Tulsa, OK, USA) orpeeso-reamer prep burs (Maillefer Instrument SA, Ballaigues, Switzerland). These instruments soften and remove gutta percha along with the plastic carrier from the coronal access to create the required space (8).

In this technique, gutta percha has optimal adaptation to the prepared canal walls and irregularities (9). Clinical service parameters in terms of speed and outcome are favorable as well (10). This technique is very quick and very sensitive and requires much exercise and training. The canal must be well flared and condensation should be done after the placement of gutta percha. If gutta percha is not well condensed, there will be a risk of void formation

(10).
Studies have yielded controversial results regarding the sealability of these materials (11). This study aimed to compare the apical seal between the Thermafil carrier and Adseal sealer, lateral condensation with gutta percha and Adseal sealer and lateral condensation with Resilon and Epiphany sealer using the dye penetration technique.

Methods:

This in-vitro experimental study was conducted on 51 human single-rooted maxillary anterior teeth. The teeth were cleaned after extraction and all hard and soft tissue appendages were removed. For surface disinfection, the teeth were immersed in 5.25% sodium hypochlorite solution for an hour and then autoclave sterilized at 121°C and 20 PSI pressure. To ensure that the teeth were single-rooted, canals were radiographed twice from the mesiodistal and buccolingual angles. The teeth were then cut with a diamond disc at the level of CEJ yielding 18 mm roots. Canal length in each tooth was determined using a #15 K file (Kerr, Romulus, MI, USA) passing the apical foramen.
Canals in the experimental and control groups were prepared with crown-down technique using rotary NiTi Flex Master files (VDW, Munich, Germany) up to #40 (0.06). Canal irrigation during instrumentation was carried out with 2.5% sodium hypochlorite. After completion of instrumentation, EDTA (10 ml) (Canal, Septodont, France) was applied to all canals and remained for 60s for smear layer removal. Final irrigation was done with 10 ml of normal saline solution. Canals were then dried with paper point (Tgdent, England).
The teeth were randomly divided into 3 groups of 15 for each technique. Six teeth were assigned to positive and negative control groups (n=3).
Group 1. Canals were filled with Adseal (Meta, Biomed, Korrea) and gutta percha (Tgdent, England) using cold lateral condensation technique. The entire surface of roots except for the apical 2mm was covered with nail varnish. Canal orifices were sealed with cyanoacrylate glue. Group 2. Canals were filled with Resilon/Epiphany (Pentron, Clinical Technologies, CT, USA) using cold lateral condensation technique. The entire surface of roots except for the apical 2mm was coated with nail varnish. Canal orifices were sealed with cyanoacrylate glue. Group 3. Canals were filled with Adseal and gutta percha using Thermafil system with plastic carrier (Dentsply, Maillefer, Switzerland). The entire surface of roots except for the apical 2mm was coated with nail varnish. Canal orifices were sealed with cyanoacrylate glue. Group 4. The negative control group included 3 roots that were filled with gutta percha using cold lateral condensation technique. The entire root surface was coated with nail varnish and canal orifices were sealed with cyanoacrylate glue. Group 5. The positive control group contained 3 roots that were not filled and covered with nail varnish except for their apical 2mm and coronal part.
Specimens were then immersed in 2% methylene blue at 37°C for 6 days. After removal from dye, the specimens were rinsed and dried. Roots were then longitudinally cut in half in a buccolingual direction. Using a caliper (2400 HSL, Berlin, Germany), apical microleakage was measured based on methylene blue dye penetration (Figure 1).

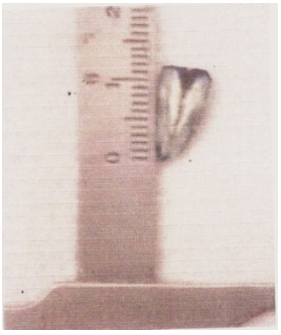

Figure 1- Measurement of dye penetration with a caliper

Measurements were repeated 3 times and recorded. Data were statistically analyzed using ANOVA and Tukey's post hoc test.

Results:

No sign of dye penetration was observed in the negative control group; which means there was no leakage. In the positive control group, specimens showed microleakage from both coronal and apical ends. The mean, standard deviation, maximum and minimum dye penetration into the canal in all three techniques are demonstrated in Table 1.

One-sample Kolmogorov Smirnov test conformed normal distribution of data. ANOVA revealed significant differences in apical microleakage between the three groups ($p<0.05$). Gutta percha/Adseal showed the lowest and Resilon/Epiphany showed the highest mean apical microleakage. Thermafil/Adseal ranked between the two (higher than gutta percha/Adseal and lower than Resilon/Epiphany). Tukey's post hoc test demonstrated that R/E had significant differences in apical microleakage with gutta percha/Adseal and Thermafil/Adseal ($p<0.05$) while the difference between gutta percha/Adseal and Thermafil/Adseal was not significant ($p>0.05$).

Table 1- Apical microleakage in the three groups

Study Groups	Microleakage Mean (SD) (mm)	Maximum Microleakage (mm)	Minimum Microleakage (mm)
Guttapercha/Adseal	6.46 (4.27)	11.06	2.15
Thermafill/Adseal	8.43 (4.48)	12.25	5.02
Resilon/Epiphany	13.47 (3.03)	15.98	9.45

Discussion:

Achieving a three-dimensional complete seal of the canal and prevention of coronal and apical microleakage are among the main goals of endodontic therapy. The present study aimed to compare apical microleakage of a recently introduced resin-based root canal filling material (R/E) with that of conventional techniques in-vitro using dye penetration method. Several techniques have been suggested to assess the quality of seal of filled canals. Dye penetration technique is among the most commonly used methods for this purpose. This method is relatively simple and does not require complex equipment (12). Studies using this technique employ different materials and dyes to assess the amount of microleakage. In our study, methylene blue was used for detection of microleakage because its molecular size is similar to that of bacterial products like butyric acid. It has been demonstrated that such products can penetrate into the periapical tissues from infected canals (13). Type of sealer in these canals is among the main differences between different root canal filling systems. In fact, application of sealer complements the canal filling and fills the irregularities and small gaps at the interface of filling material and canal walls. Also, sealers act like lubricants and enhance the insertion of cones. It has been shown that accessory canals and multiple apical foramina can be filled with sealer as well. Thus, application of sealer to the canal should be done with utmost care (14). According to an in-vitro study, inadequate apical seal is responsible for up to 60% of treatment failures (14). Several sealer compositions have been suggested for root canal treatments yielding variable in-vitro and clinical outcomes (15-17). For instance, some

primary studies like the one by Limikangwalmongkol *et al*. in 1992 (18) suggested AH26 as the best available sealer in terms of microleakage. In the recent years, several sealers have been introduced into the market replacing the traditional ones such as Apexit; which belongs to the category of calcium hydroxide sealers manufactured based on the optimal characteristics of calcium hydroxide (19, 20). Bis-GMA resin-based sealer usually incorporated into the R/E systems is a dual-cure resin with a resin matrix containing Bis-GMA, ethoxylatedBis- GMA, urethane dimethacrylate (UDMA) and hydrophilic difunctional methacrylates. It also contains fillers like calcium hydroxide, barium sulfite, barium glass, bismuth oxychloride and silica. These fillers comprise 70 weight percent of the compound. This sealer has high radiopacity and is biocompatible. More importantly, it adheres to the Epiphany primer and resin core simultaneously creating a mono-block structure and preventing the transmission of irritating agents (21). Adseal is an epoxy-resin based sealer gaining popularity due to its optimal characteristics. Its working time according to the manufacturer's instructions and ISO 6876:1986 is 35 min after mixing and its setting time is 45 min. These characteristics are responsible for the superiority of this sealer over the previous ones.

Studies evaluating apical microleakage of different root canal filling techniques have reported different and sometimes controversial results (22). However, to the best of our knowledge, no study has compared the apical seal of Thermafil/Adseal and R/E with cold lateral condensation. But, several studies have evaluated apical microleakage in different root canal filling systems. There is no doubt that each study is unique considering its methodology, understudy materials and employed techniques and these characteristics affect the obtained results (23). Punia *et al*. in 2011 studied the apical microleakage of canals filled with Resilon, Thermafil and lateral condensation and found that Resilon had the lowest degree of microleakage in comparison to other techniques (24). Shipper *et al*. in 2004 in a similar study assessed the microbial leakage of canals filled with R/E and reported that Resilon had the lowest degree of microbial leakage compared to other techniques (25). Kocak *et al*. in 2008 investigated the apical leakage of canals filled with cold lateral condensation, Thermafil and Resilon/Epiphany and reported that apical microleakage in cold lateral condensation and R/E was acceptable and significantly less than that of Thermafil technique (26). Some others believed that the differences between these techniques were insignificant and ineffective in their clinical trials.De Almeida Gomes *et al*. in 2010 evaluated the apical and coronal leakage of root canals filled with cold lateral condensation and R/E and showed that apical microleakage in the mentioned techniques was not significantly different (27). Our study results similar to many others indicated that none of the canal filling systems can provide a hundred percent complete seal of the canal; but a root canal properly filled with gutta percha with lateral condensation technique has the lowest microleakage compared to other techniques. Canals filled with gutta percha using the Thermafil technique showed significant apical microleakage. The highest apical microleakage was observed in teeth filled with R/E. However, it should be noted that leakage in our study was evaluated in-vitro using the dye penetration technique and different results may be obtained in clinical settings due to differences between the oral cavity and in-vitro conditions. In the oral cavity, blood and intercellular fluids decrease the concentration of materials. Also, the temperature of oral cavity is different from the lab temperature and presence of blood and variable oxidation-reduction potential at different parts of the oral cavity can affect the results (28). Thus, considering the differences between in-vivo and in-vitro

conditions, our obtained results may not be completely generalizable to the clinical setting. Obviously by simulating oral cavity conditions as much as possible, valuable results can be obtained.

Conclusion:

Our findings indicated that significant differences existed between the three techniques in terms of apical microleakage. Gutta percha/Adseal had the lowest and R/E had the highest mean apical microleakage. Thermafil/Adseal ranked second. It has been proven that gutta percha is successful in long-term and still has the lowest apical microleakage. Further investigations are required to find new materials with properties superior to those of gutta percha.

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Conflict of Interest: "none Declared"

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