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Research Paper: Comparison of Apical Seal of Three Obturation Techniques after Post Space Preparations

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ABSTRACT

Introduction: The ultimate goal of endodontic treatment is to prevent pathogens from entering the root canal and surrounding tissues. The quality of root canal filling is a leading factor determining the success or failure of root canal treatment. This study was carried out to compare the apical seal of teeth prepared for post space using three different techniques of root canal filling.

Materials and Methods: Experiments were conducted on 36 human extracted anterior and permanent single canal teeth. Participants were divided into three subgroups, each with 12 members. Cold Lateral Compaction (CLC), Warm Vertical Compaction (WVC), and Single Cone (SC) techniques were used to fill the canal respectively in subgroups I, II, and III. The coronal part of the root canal was removed in order to prepare the post space for filling. Pelican ink was utilized to examine the penetration of linear leakage, and dye penetration was measured by a stereomicroscope. The normality of the data was assessed using the Shapiro–Wilk test, and Levon's test was employed to study the homogeneity of variance of the studied groups. Groups were compared using the Kruskal-Wallis nonparametric test, and ultimately, the Mann-Whitney test with Bonferroni correction was used for the pairwise comparison of groups.

Results: The mean leakage in CLC and WVC techniques was lower than that of the SC technique. The highest leakage (6.32 ± 1.20 mm on average) was observed in the SC technique, followed by the CLC technique (5.49 ± 1.23 mm on average), and the WVC technique (4.95 ± 1.35 on average). A meaningful difference was observed between WVC and SC techniques ($p = 0.021$).

Conclusion: CLC and WVC techniques yielded a lower mean leakage and better apical seal, as compared to the SC technique.

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Introduction

Endodontic treatment aims to eliminate microorganisms and intracanal infection and restore the health of dental tissue (1). Sealing bacteria, tissue debris, and other irritants during filling can prevent them from penetrating the surrounding tissues. Proper sealing of apical foramen can largely prevent irritants from penetrating surrounding tissues (2-5). The complete debridement of the canal is not always practical (6) and dead tissues, bacteria, and other irritants are usually not fully eliminated while clearing and shaping the canal space. These materials and agents can act as a stored source of stimulus causing failure to the treatment plan (7,8). Furthermore, according to studies, some bacteria sealed in the canal may lose their lives due to the deficiency of nutrients (3,9,10). Degradation may not sound in the short term, normally due to the small volume of irritants or the slow release of these substances into the periapical space (11). Therefore, canal filling has perpetually been a determinant step in endodontic treatments and the cause of most endodontic treatment failures (10). Factors influencing a proper apical seal include the technique of root canal preparation (10), enlargement of the apical foramen (12,13), smear layer (14), dentinal plate (12,15), different materials used in root canal filling, techniques of root canal filling (14,16), and conformity and uniformity of canal filling in three dimensions (14,17).

Burns and Cohen reported that a total of 60% of unsuccessful endodontic treatments are due to insufficient sealing in the apex of the tooth, with a corresponding 58.66% reported by Ingle. There is a potential association between the pulp space and the pre-apex. Therefore, tissue materials and fluids along with plasma proteins may penetrate the canal space via the leakage property. This can allow the bacteria to multiply, where bacterial toxins can return to the periapical tissue and cause inflammation (7). Therefore, the goal of canal filling can be eliminating all leakage pathways from the oral cavity or tissues surrounding the root into the canal complex and depriving the canal irritants of nutrients, as the cleansing and shaping steps can not eliminate irritants thoroughly (14).

Numerous techniques have been proposed to fill the root canal, including Cold Lateral Compaction (CLC) (2), Warm Vertical Compaction (WVC), and Single-Cone Gutta-Percha (2). Studies are still ongoing to apply these techniques and various other tools to obtain the best apical seal. These studies focus mainly on fine tips to eliminate or minimize therapeutic failures such as the volume of Gap and Void within the canal and the spread of sealers (1,18-21). A comparison of the apical sealing when using each of the instruments during the post space preparation is still a topic of interest in studies (22, 23).

Given the importance of choosing the appropriate technique for filling the canal space in endodontic treatments, this study attempts to investigate the difference in the apical seal of teeth with various obturation techniques after post space preparations.

Materials and Methods

Experiments were carried out on 36 human extracted anterior and permanent single canal teeth in the Dental School of Guilan University of Medical Sciences (GUMS). Samples extracted due to periodontal and prosthetic problems were available in clinics in the city and were collected by convenience sampling. Inclusion criteria were single-canal teeth with similar dentinal plug thickness and healthy teeth with slightly occlusal caries and the straight root. Exclusion criteria were fractures, resorptions, and lesions (15 mm from tooth apex), calcification of the canal, severe caries in the root.

After the approval of the ethics committee and obtaining the ethics code (IR.GUMS.REC.1398.426), 36 human extracted anterior and permanent single canal teeth were selected. Samples were divided into three groups and the mean sample size was 12 for each group, according to the performance curve, mean values of 6.02, 2.87, and 7.70, the statistical power of 0.84, and α of 0.05, and standard deviation (SD) of 3.53 obtained from previous studies (1).

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The linear dye penetration technique was used to investigate the leakage rate. A triple comparison of negative and positive control of lacquer coverage was performed to ensure the dye penetration into the root canal.

Teeth with inclusion criteria were selected after examination under magnification. The dental corona at a distance of 15 mm to the apex was fully removed by diamond discs (China, Penghao). The operating length was determined by K-File 15 by subtracting 0.5 mm from the file length when it was visible in the apical foramen as well as radiographs. Then, the root canal was cleaned and shaped with an M3 nickel-titanium (NiTi) rotary with sequences of 19 (2%) (Path File), 17 (8%) (Open File), 15 (6%), 25 (4%), and 35 (4%).

Samples were washed with 2.5 ml of 2.5% sodium hypochlorite between each rotary file and after preparation. The root canals were washed with 5 ml of 17% EDTA for 1 minute followed by 5 ml of 2.5%NaOCl for 1 minute. Ultimately, the root canals were washed with 5 ml of distilled water and dried with Paper Point.

The samples were randomly distributed into three experimental groups (n=12) according to the filling technique used.

CLC Technique Group:

Samples were filled using the CLC technique with gutta-percha (Meta BioMed, South Korea) and AH26 sealer (DentsplyDeTrey GmbH, Konstanz, German). A 35 gutta-percha (Tip Size 35 and the proximity of 2%) was smeared with the sealer and guided through the canal during the operation. Then, the sub-guttas were pressed into the main gutta in the same way and laterally with a spreader No. 25.

WVC Group Technique:

A suitable plug tip of an obturation unit (Cordless Root Canal Obturator Master, BioMed, South Korea) penetrating 4 mm shorter than the operating length was selected for each channel. Then, 0.5 mm of the end tip of a gutta-percha (Meta Biomed, South Korea) (Tip Size 35 and the proximity of 6%) was cut off, impregnated with sealer, and was inserted into the canal 0.5 mm shorter than the operating length. The heating source of the obturation unit was adjusted to 200 °C, and the heated plugger was compressed gently toward the gutta-percha so that 4 mm of gutta-percha was left in the apical area. At this point, the heat source was switched off, and the plugger was pressed apically for 10 seconds. The heat source was reactivated for 1 second to allow the plugger to be released from the gutta-percha assembly. The residual filling material was then compressed vertically with a manual sprayer, and ultimately, the remaining canal was filled with a flexible gutta-percha using an obturation unit.

SC Technique Group:

A gutta-percha (Meta South Korea) (Tip Size 35 and the proximity of 6%) was impregnated with a sealer and inserted into the root canal equal to the operating length.

In all groups, excess material was removed with a heated instrument, and vertical compaction was done using a cold plugger 1 mm below the root canal orifice. The final radiograph was practiced to confirm the uniformity and density of the filling. The teeth were kept at 37 ° C and 100% humidity for 1 week to allow the sealer to set (1).

Post space preparation:

The coronal part of the root filling was removed by piezometers (PD Peso reamer, Switzerland) (sizes 2 and 3), so that only 4 mm of filling material remained in the apical part. Samples were washed with 2 ml of 2.5% NaOCl solution between each piezo. Ultimately, each root canal was dried with Paper Point (1). In order to equalize the coronal seal and for the maximum simulation of the tooth condition with when the post was cemented, the entire prepared canal space was sealed with a self-cured glass ionomer (Oxford GiCem, Germany) and filled with Paper Point. The post was not cemented due to the improper alignment of the metal post with the channel wall and the difficulty and relatively impossi-

bility of removing the post fiber after sticking.

In this study, an experimental operator performed the root canal preparation and filling unit and a secondary operator who had no familiarity with the samples performed the post space preparation operation.

The linear dye penetration technique was used to investigate the amount of leakage. All teeth were covered with two layers of nail polish (water-resistant) on all surfaces up to 4 mm of the apical foramen.

All teeth were kept in a solution of pelican ink at 37 °C and 100% relative humidity for 24 hours. Then, the extracted teeth were rinsed with pressured water and allowed to be dried for 24 hours.

Then, an entirely longitudinal incision was made between the buccal and lingual surfaces of the teeth with a Diamond Taper Milling Cutter and turbine and a little water spray so that it passes at least half of the dentinal wall around the canals. Then, the teeth were halved by placing a spatula in the incision and applying buccolingual pressure so that the amount of ink leakage can be seen between the root canal wall and the filling material. Measurements were done in mm (23).

The ink leakage was read by a single-blinded operator. The highest dye leakage between the two halves of the tooth root was measured using a stereomicroscope (Olympus SZX7) and double magnification.

In this research, descriptive statistical methods (mean and SD) were used to describe the obtained data. The assumptions related to parametric tests were first examined to analyze the research hypotheses. For this, the normality of the studied data was evaluated using Shapiro – Wilk test, and the homogeneity of variance of the studied groups was evaluated with Levon's test. The Kruskal Wallis non-parametric test was used to compare the groups after the hypotheses were not confirmed, and the Mann-Whitney test with Bonferroni correction was used for pairwise comparison. Calculations were done in IBM SPSS Statistics v24 at α of 0.05.

Results

The effect of post-space preparation on the quality of apical seal in aborted teeth was assessed. The mean leakage rate in the CLC technique group was calculated to be 5.49 ± 1.23. The mean leakage in SC and WVC groups were respectively 6.32 ± 1.20 and 4.95 ± 1.35. Table 4.4 shows the normality of the studied groups, where the WVC group does not shows a normal distribution. Homogeneity of variance within the groups was confirmed using the Leven test (p = 0.861, Levene = 0.151). It was not possible to use a parametric ANOVA due to the non-normality of one of the groups tested. Therefore, a non-parametric alternative to this test (i.e., the Kruskal-Wallis test) was employed.

Table 4.5. A comparison of the rate of leakage between groups

Group	Test statistic	Degree of freedom	P-value
CLC	0.895	12	0.138
SC	0.976	12	0.961
WVC	0.795	12	0.008

Table 4.5 shows the mean leakage rate for each of the studied groups, where there is a meaningful difference between the groups in terms of the mean leakage rate (p = 0.021).

Table 4.5. A comparison of the rate of leakage between groups

Group	No	Mean (SD)	Test statistic [a]	P-value
CLC	12	5.49±1.23	7.68	0.021
SC	12	6.32±1.20		
WVC	12	4.95±1.35		

[a]Kruskal-Wallis test

The highest and least leakage rate was observed in the SC and WVC groups, respectively. For pairwise comparisons, the Wilcoxon test with Bonferroni correction was used (Table 4.6).

Table 4.6. A pairwise comparison of groups for mean leakage

	CLC	SC	WVC
CLC	-	-	-
SC	0.411	-	-
WVC	0.599	0.017	-

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According to the results of Table 4.6, there is a meaningful difference between WVC and SC groups (p = 0.017). The mean leakage rate was lower in the WVC group.

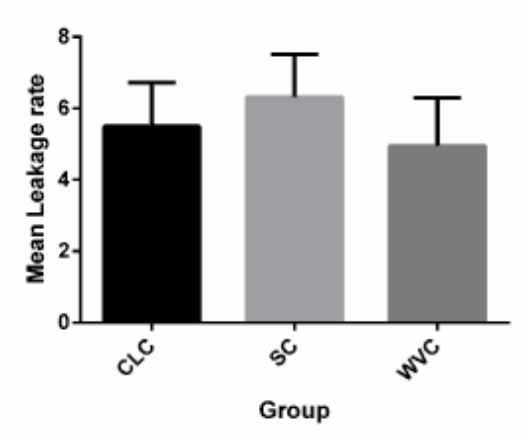

Fig. 4.1. Mean leakage rate in groups studied

Discussion

This study was carried out to investigate the difference in the apical seal of teeth prepared for post preparation in teeth obturated with different techniques. Experiments were conducted on 36 human anterior and permanent single canal teeth extracted from patients with periodontal and prosthetic problems. In order to evaluate each of the techniques for filling the canal, teeth were divided into three subgroups, each with 12 samples.

According to the results, there was a significant difference between the studied groups in terms of mean leakage rate (p = 0.021). The highest and least mean leakage rate was observed respectively in SC and WVC groups. Pairwise comparisons between the studied groups showed that the mean leakage in the WVC group is significantly different from that of the SC group (p = 0.017). The mean leakage was lower in the WVC group. ErenSk et al. examined the apical seal of obturated teeth with three different techniques after preparing the post space by Micro-CT. They studied 30 permanent single-root mandibular premolars and found that after preparing the post space, the best obturation is achieved in the teeth of the WVC group. These findings were consistent with the results of our study (1).

A. Keles, H. Alcin et al. examined the quality of elliptical canal fillings using both CLC and WVC techniques by Micro-CT. In their study, 24 maxillary single canal premolars were divided into two groups. The WVC technique showed a lower Void rate than the CLC technique, while no significant difference was observed in the apical part of the filling (19). In the present study, there was no significant difference between CLC and WVC techniques in terms of mean leakage (p = 0.599).

Sarin, Gupta et al. studied the effect of different filling techniques on the prognosis of endodontically treated teeth. A total of 140 patients were divided into two groups, and their teeth were filled by Carrier-Based Obturation (CO) and LC filling techniques. The mean age was 43 in CO and 48 in LC techniques. During follow-up, no significant difference was observed in the success or failure of treatment. However, the type of tooth and the presence of Void were effective in the outcome of treatment (18). In this study, no meaningful difference was observed in terms of mean leakage between CLC and WVC techniques.

Beenish Qureshi et al. compared the quality of root canal filling in both Thermafill and LC techniques. They studied 60 mandibular premolars of patients with irreversible pulpitis. Patients were divided into two groups and treated. Radiographic results showed Void for 20 teeth (33.3%), with three Voids for the Thermafill techniques and 17 in the Lateral Condensation technique. The Thermafill technique was more efficient in terms of filling quality and Void creation (20).

Conclusion

According to the results, there was no meaningful difference in the mean leakage rate between CLC and WVC techniques. The mean leakage in the SC technique was higher than that of CLC and WVC groups. Furthermore, there was a significant difference between the two groups of WVC and SC in terms of the mean leakage rate.

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