



An *in-vitro* Comparative Evaluation of the Influence of Immediate and Delayed Post-Space Preparation on the Apical Seal: A Stereomicroscopic Study

Kurchi Mandal¹, Priyadarshi Vaibhav², Parthasarathi Mondal¹, Snigdho Das³, Anshuman Khaitan¹

¹Department of Conservative Dentistry and Endodontics, Dr.R Ahmed Dental College and Hospital, Kolkata, West Bengal

²Private Practitioner, Kolkata, West Bengal

³Department of Dentistry, Ramakrishna Sarada Mission Matri Bhavan and Hospital, Kolkata, West Bengal

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KEYWORDS

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ABSTRACT:

Aim: To evaluate the effect of immediate and delayed post-space preparation, on the apical seal

Materials and Methods: Sixty-five extracted permanent maxillary central incisors were procured and decoronated. Samples were divided equally into groups of twenty each (n=20) for Groups I, II, and III and 5 for Group IV. Groups I and II were the study groups with immediate and delayed post-space preparation respectively. Groups III and IV served as positive and negative controls respectively. Root canals were instrumented and obturated in the study groups and the positive control group, while it was kept unobturated in the negative control group. After the required sealing, the samples were kept in India Ink dye and evaluated for microleakage under a stereomicroscope.

Statistical Analysis: The obtained data was subjected to statistical analysis using the One-way Analysis of Variance(ANOVA) test with the post-hoc Tukey test. The significance level was set at 5%(P<0.05).

Results: The mean microleakage in Groups I, II, and III were found to be 0.53±0.63 mm, 1.06±0.79 mm, and 5.88±0.652 mm respectively. A statistically significant difference was found between all the study groups(P<0.05).

Conclusion: An immediate preparation of a post-space using a heated endodontic plugger significantly contributes to a lesser microleakage.

1. Introduction

Endodontic therapy aims to prevent & treat the disease of pulp and peri-radicular region. Success in endodontic treatment was originally based on the triad of thorough debridement, thorough disinfection, and a three-dimensional obturation of the root canal space.[1] An adequate coronal seal and post-endodontic restoration also govern the treatment success. Often, invariably, an endodontically-treated tooth with compromised tooth structure may necessitate the placement of an intra-radicular post to retain a core. Post-space preparation can be either done immediately after the obturation procedure or at a later stage following the complete setting of the sealer.[2] The major concern regarding the time of the post-space preparation pertains to its effect on the integrity of the apical seal. It is, however, subjected to contradicting views, with no consensus achieved.

In view of the conflicting results in the literature, the present *in-vitro* study was designed to evaluate and compare the apical microleakage, when post-space preparation is done at different timings.

2. Methods

Sample preparation

Sixty-five single-rooted Maxillary central incisors, extracted due to periodontal causes were procured from the Department of Oral and Maxillofacial Surgery of the Dental College and Hospital. After procuring, the teeth were stored in 10% buffered formalin and physiological saline solution before instrumentation. Teeth with root caries, open apices, having a fracture or crack, or with a calcified canal were excluded.

The final selected sample teeth were then decoronated with the help of a diamond cutting disc to a standardized



length of 16 mm and a flat plane was prepared. Following this, the canal patency was determined by passing a #20 K file (Dentsply Malliefer, Ballaigues, Switzerland), and the working length was recorded. Chemo-mechanical preparation was carried out till #60K file as the Master Apical File in a step-back fashion, with a concentration of 5.25% Sodium Hypochlorite (NaOCl) (Prime Dental Products, Mumbai, India) and 17% ethylenediamine tetraacetic acid (EDTA) (SmartPrep, SafeEndo Dental, Vadodara, India) was used both intermittently and as a final irrigant to cleanse organic and inorganic debris respectively.

The tooth samples were then divided into four groups with each Group I, II, and III containing twenty teeth (n=20) and Group IV containing five teeth (n=5)

Classification of groups

Group I: Immediate post-space preparation

Group II: Delayed post-space preparation (after one week)

Group III: Positive Control (Obturation with no sealer and no post-space preparation)

Group IV: Negative Control (no obturation)

Samples belonging to Group I, II, were obturated using AH Plus sealer (Dentsply Sirona, USA) and with gutta-percha by the standardized cold lateral condensation technique, whilst Group III samples were obturated in the absence of a sealer.

Preparation of post-spaces

Post-space preparation was done in Group I by an appropriate size of heated endodontic plugger leaving 5mm of gutta percha apically in 20 teeth. The remaining apical GP was gently vertically condensed with the cold side of the endodontic plugger.

For Group II samples, the teeth were maintained in an incubator at 100% humidity and 37°C for one week & post space was prepared after one week by an appropriate size of heated plugger leaving 5mm of gutta-percha apically. The remaining apical GP was gently vertically condensed with the cold side of the endodontic plugger.

Peri-apical radiographs were taken to ensure adequate preparation of the post-spaces.

In the positive and the negative control group, no post-space preparation was done.

The coronal openings of the first three groups were sealed with sticky wax & two coats of nail varnish were painted on covering the entire outer root surface except for the last 2mm apically, while for the negative control

group, the same procedure was carried out for the whole of the outer surface.

Evaluation of apical seal

The prepared samples were next placed in India ink dye for 72 hours. After removal from the dye solution, the specimens were washed & dried. Dye from the apical portion & nail varnish from the root surface were removed with No. 15 Bard Parker Blade.

The teeth were then sectioned vertically along the buccolingual direction using a diamond disc. Apical dye penetration was then studied under a Stereomicroscope (Zeiss Stemi 2000-C, Carl Zeiss, Munich, Germany) at 16X magnification (Figure 1) and measured using a digital vernier caliper (Workzone, China).

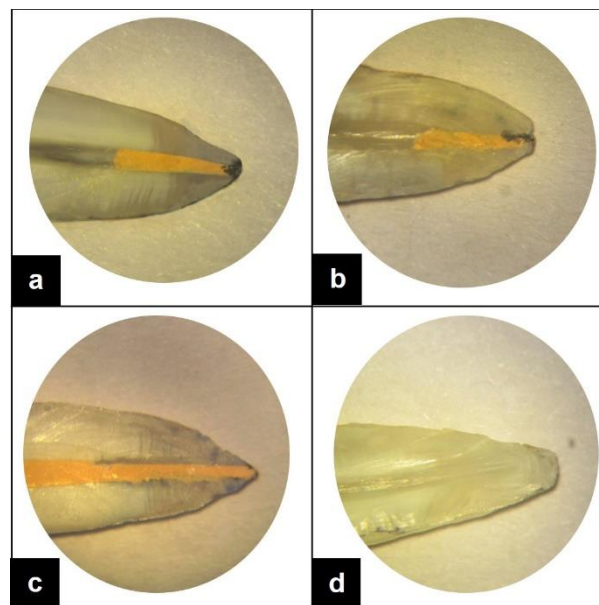


Figure 1: Stereomicroscopic images of study and control groups under 16X magnification: (a) Group I: Immediate post-space preparation, (b) Group II: Delayed post-space preparation, (c) Group III: Positive Control, (d) Group IV: Negative Control

Statistical Analysis

The values thus obtained were tabulated in a spreadsheet using Microsoft Excel 2019 and then statistical analysis was carried out using GraphPad Prism for Windows, Version 9.5 (GraphPad Software, La Jolla California USA). A Shapiro-Wilk's test and a visual inspection of the histograms, normal Q-Q plots, and box plots showed that the collected data were approximately normally distributed for both the groups, and thus analysis was



carried out using One-way analysis of variance (ANOVA) with the *post-hoc* Tukey test. The *P* value of ≤ 0.05 was considered as the level of significance.

3. Results

The values of microleakage in decreasing order were as follows: positive control (5.88 ± 0.652 mm) > Group II (1.06 ± 0.79 mm) > Group I (0.53 ± 0.63 mm) and the least in negative control (0 mm). Multiple comparisons revealed that the differences between all the study groups were statistically significant ($P < 0.05$) (Table 1 & Figure 2). Thus, it could be inferred that Group I is the group where post-space preparation was done immediately, and exhibited the best sealing ability, only less than that of the negative control.

Table 1: Mean microleakage values for all the study groups

Study Groups		Control Groups		P value
Group I: Immediate post-space preparation n	Group II: Delayed post-space preparation n	Group III: Positive Control 2 mm ^c	Group IV: Negative control 0 mm ^d	
0.53 ± 0.63 mm ^a	1.06 ± 0.79 mm ^b	5.88 ± 0.65 mm ^c	0 mm ^d	<0.001* *

n: sample size per group (Total sample size = 65)

** : Highly statistically significant

Different superscript letters denote a statistically significant difference between study groups by the *post-hoc* Tukey test ($P < 0.05$)

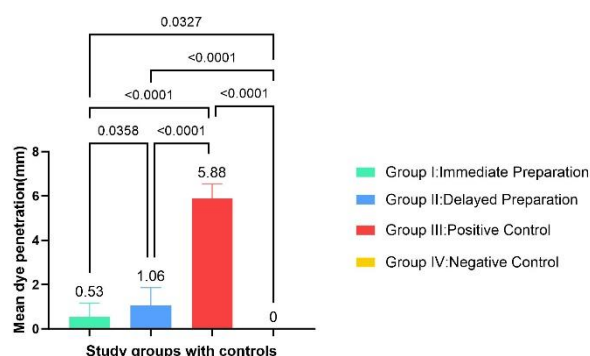


Figure 2: Bar Graph showing the mean microleakage values of the study and the control groups and the significant comparisons between them.

4. Discussion

Adequate canal disinfection and the integrity of canal fillings are essential for successful root canal therapy. Microleakage occurs wherein microorganisms, their associated toxins, oral fluids, and ionic particles pass into the dentinal tubules.[3]

Intra-radicular post is used when there is insufficient tooth structure remaining to support the final restoration. This involves the creation of a post space by partial removal of the obturating material from the root canal and while doing so it is essential not to affect the apical seal. Several factors can affect the integrity of the apical seal during a post-space preparation such as length of remaining gutta-percha, time, and method of gutta-percha removal. [4,5]

This study was undertaken to evaluate the effect of time of post-space preparation on the apical seal, comparing the same with an adequate control group, as a similar study on a larger sample size is sparse according to the best of the authors' knowledge.

Microleakage studies have utilized methods such as dye penetration, pressurized fluid filtration, fluid transport, electrochemical methods, radioactive isotopes, and bacterial leakage.[6] The current study employed the India ink dye penetration method to evaluate microleakage, as it has been adjudged as the most sensitive method in studying the same as it has particles smaller than or equal to $3 \mu\text{m}$, which are smaller than those of bacterial molecules, thereby it is unlikely that bacterial invasion would occur inside the canal where this dye is unable to penetrate, warranting adequate clinical corroboration of the in-vitro results.[7]

Also, in the current study, 5 mm of gutta-percha was left as the remaining root end filling material as this has been recommended as a safer margin in previous studies. [8,9] In the present study, according to the result of statistical analysis, the least apical leakage among the experimental groups was found in specimens where post-space preparation was done immediately after obturation, which was concordant with the findings of Padmanabhan *et al.*[10] and Dhaded *et al.*[11] that an immediate post-space preparation resulted in a significantly lesser microleakage than prepared later. The probable explanation of the phenomenon can be attributed to the fact of lesser disturbance of an already set sealer, which is in the case of a delayed preparation.[12] This finding was however in contradiction to the results of Cheng *et*



al.[8] The discordant finding may be due to the differences in the instrumentation used as well as differing root canal obturation protocols.

Also, in the present study, immediate post-space preparation was achieved by a heated plugger. This is in agreement with the results of the study conducted by Shahi *et al.*[13] who evaluated the effect of immediate & delayed post-space preparation on apical leakage, using peeso reamers & heated pluggers to create a post-space. The study concluded that the most appropriate time and procedure for post-space preparation was immediately after canal obturation using a heated plugger.

A higher apical infiltration of the dye can be also attributed to the movement of gutta-percha during post-space preparation with drills, which jeopardizes the adhesion at the sealer/dentin interface.[14] It was also hypothesized that if an immediate post-space preparation is done, the sealer which has not completely formed a lasting bond and is still within its working time; introducing a heated plugger to remove the gutta-percha at this time, neither doesn't cause any microfractures nor hamper the setting of the sealer. However, during a delayed post-space preparation, after the complete polymerization of the sealer movement of gutta-percha during its removal, may result in a large number of gaps at the dentin/sealer interface. [1,11]

Although the present study was undertaken under optimal conditions concerning storage, instrumentation, dye penetration, and calculation of the microleakage data, it cannot be overlooked that the study carries the inherent disadvantage of being an *in-vitro* study.

5. Conclusion

Within the parameters and limitations of the current study, it can be inferred that an immediate preparation of a post-space with a heated endodontic plugger leads to lesser microleakage, thus maintaining an optimum apical seal. Further investigations in clinical conditions using various sealers and obturation techniques should be carried out to gain more insight into this topic.

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