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## Research Article

### A COMPARISON OF APICAL LEAKAGE BETWEEN IMMEDIATE VERSUS DELAYED POST SPACE PREPARATION USING TWO SEALERS: AN IN VITRO STUDY

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#### ABSTRACT

**Aim:** Aim of this in vitro study is to ascertain whether immediate or delayed post space preparation would affect the apical seal obtained using two different root canal sealers. **Materials and Methods:** Seventy freshly extracted human permanent intact maxillary central and lateral incisors (anterior teeth) with straight and single patent root canals were decoronated, irrigated using 5% sodium hypochlorite & 17% EDTA; biomechanical preparation was done followed by obturation. The obturated teeth were randomly divided into 6 groups depending on the post space preparation time and obturation materials used. Group I and II: Immediate and delayed post space preparation respectively with Gutta percha/AH plus as obturating material. Group III and IV: Immediate and delayed post space preparation respectively with Gutta percha/Apexit Plus as the obturating material. Group V & VI served as positive & negative controls respectively and contained 5 teeth each. The samples were suspended in methylene blue dye, after which they were sectioned and measured & studied under stereomicroscope. **Statistical Analysis** The data was subjected to statistical analysis using Mann Whitney U test. **Results:** No statistically significant result was found between the two obturating materials for delayed post space apical leakage.

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#### INTRODUCTION

The final objective of endodontic procedures should be the total obturation of the root canal space. Biologic necessity requires the elimination of the protein degradation products, bacteria and bacterial toxins which emanate from the necrotic and gangrenous root canals while these irritants may be eliminated by extraction of the tooth, the health of the dentition is secured more soundly if they are eliminated by cleaning and shaping, sterilization, and total obturation of the root canal system. In the final analysis, it is the sealing off of the complex root canal system from the periodontal ligament and bone which ensures the health of the attachment apparatus against the breakdown of endodontic origin.<sup>1</sup> In unusual conditions, it may be necessary to seal off the root canal by means of the reverse root end filling, while incarcerating potentially injurious agents inside the tooth; however it is desirable and possible to clean and shape the root canal in their entirety and to obturate them totally.<sup>1</sup> It is well understood that when filling the root canals with a solid core material, some form of cement is required for a fluid tight seal that fills the minor gaps between the core material and the dentinal wall of the canal to prevent leakage. According to Orstavik, sealers play an

important role in sealing the root canal system with entombment of the remaining microorganisms and filling of the inaccessible areas of the prepared canals. Sealer selection may influence the outcome of endodontic treatment.<sup>2</sup> Endodontically treated teeth with insufficient coronal tooth structure generally require radicular post to assist in restoring the tooth to function. During post space preparation in teeth with insufficient coronal architecture, it is vital not to disrupt the integrity of the apical seal.<sup>3</sup>

#### MATERIALS AND METHODS

Seventy freshly extracted, caries-free and fracture-free, human permanent maxillary central and lateral incisors (anterior teeth) with straight and single patent root canals, which have completely formed apices, and without resorption, those are planned for extraction within six month period of start of the study were collected. Teeth were cleaned to remove soft tissue remnants, calculus and stain & stored in 10 % formalin for one week. They were then washed with water and stored in normal saline (0.9 % sodium chloride) to keep them hydrated till further period of study. The crowns of all seventy teeth were severed at proximal cemento-enamel junction perpendicular to

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the long axis of teeth using carborundum disc mounted on a straight micro motor hand piece with a high speed water spray to facilitate straight line access for precise length control and easy canal preparation. The teeth were decoronated to a length of 16 mm and a flat occlusal plane was prepared for each tooth to serve as a fixed coronal reference point for all measurements. Standard access to the root canal system was prepared. The root canals were cleared of pulpal remnants, the canal patency was determined by passing no. 15 k-file into the root canal until the tip of the file was visible at the apical foramen and the working length established. The coronal two third of each canal was flared using Pecho reamers no. 1, 2 & 3. All the teeth were instrumented to apical file size of 50 by using step-back technique with frequent recapitulation of files to establish a progressively tapering root canal preparation. Chemical cleaning of the canal was achieved with 15% EDTA gel & 5 ml of 5% NaOCl solution. The final rinse was done with 10 ml of 17% EDTA solution for 1 min followed by 10 ml of 5% sodium hypochlorite solution for 1 min followed by 10 ml of 5% sodium hypochlorite solution and 0.9% saline. Frequent recapitulation was done to maintain the patency of the canal. All the specimens were held in moist gauze while they were being instrumented to avoid dehydrating the specimens. Paper points were used to dry the teeth and randomly divided into six groups.

Group I- IV contained 15 teeth each. Group V & VI served as positive & negative controls respectively and contained 5 teeth each.

**I:** Obturation using AH Plus sealer followed by immediate post space preparation [AHP Imm]

**II:** Obturation using AH Plus sealer followed by delayed post space preparation [AHP Del]

**III:** Obturation using Apexit Plus sealer followed by immediate post space preparation [Apexit plus Imm]

**IV:** Obturation using Apexit Plus sealer followed by delayed post space preparation. [Apexit plus Del]

**V:** Positive control.

**VI:** Negative control.

Paper points were used to dry the canals. The instrumented specimens were taken and standardized gutta-percha master cones of size 50 that fit with the tug back at the working length were selected for each specimen and radiographs were taken. The sealers were manipulated according to the manufacturer's instructions and were introduced into the prepared canal using a lentulospiral no. 40. The obturations were carried out using lateral condensation technique. Radiographs were taken to evaluate the status of the root canal filling. If the obturation appeared to be inadequate, the root canal filling was removed and refilled.

Positive control was formed by teeth that were only obturated with gutta-percha to fit tug-back with no sealer. Negative control was formed by teeth that were instrumented, with no obturation material placed and the teeth were completely sealed with sticky wax and finger nail polish. In groups I and III, post space was prepared immediately at the time of obturation using hot pluggers & Pecho reamers in a slow speed hand piece at a constant rpm, to a depth that left 5 mm of remaining gutta-percha apically in the root canal. The post space was prepared till Pecho size 3. Multiple studies have demonstrated that there is no difference in leakage between removing gutta-percha with

hot instruments and removing it with rotary instruments. In Group V Positive control was formed by teeth that were only obturated with gutta-percha to fit tug-back with no sealer.

Group VI consisted of negative control where the teeth were instrumented, with no obturation material placed and the teeth were completely sealed with sticky wax and finger nail polish. All the teeth were placed in capped vials containing 2x2 inch gauze pads saturated with normal saline at 37°C in an incubator for 1 week after obturation, to simulate the clinical situation.

#### **Placement of the Specimens in the dye**

All the specimens including the positive and negative controls were vertically suspended in 2% aqueous solution of Methylene Blue dye buffered to pH7 for 24 hrs. Thereafter, the specimens were taken out and washed under running tap water for 20 minutes. The specimens were sectioned using diamond coated disc longitudinally.

#### **Measurement of dye penetration**

The specimens were taken and mounted on a stand and the coronal extent of the dye penetration was measured using a Stereomicroscope. The measurements were made at a magnification of 4X.

#### **Apicocoronal Dye leakage studied under stereomicroscope**



**Apical leakage observed in immediate post space preparation using AH Plus**



**Apical leakage observed in delayed post space preparation using AH Plus**

**Statistical Analysis**

The Data was entered in Microsoft excel 2010 for Windows. Mean, standard deviation, minimum and maximum values of apical leakage in immediate and delayed post space preparations in AH plus, Apexit plus, positive and negative control groups were calculated. Shapiro-Wilk test showed that apical leakage in immediate and delayed post space preparations in different groups did not follow normal distribution curve. Hence, non-parametric tests namely, Kruskal Wallis test followed by Mann Whitney U test were considered for comparison between AH plus, Apexit plus, positive and negative control groups.

Comparison of apical leakage between immediate and delayed post space preparation in AH Plus and Apexit Plus was performed using Mann Whitney U test. P values <0.05 were accepted as statistically significant. All analyses were performed using version 21.0 of the Statistical Package for Social Sciences (IBM Corporation, Armonk, New York, USA).

**RESULTS**

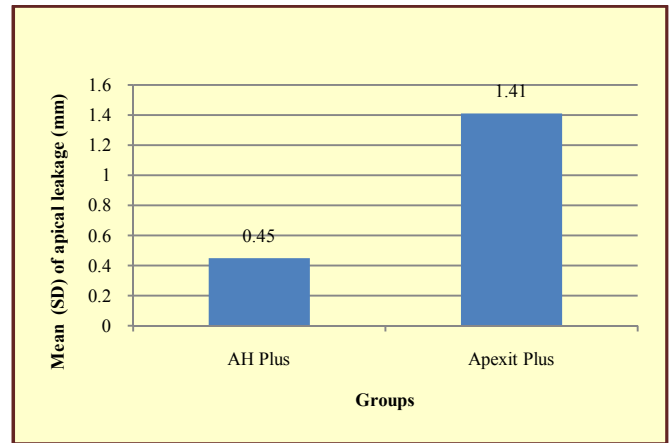
The time of post space preparation has a strong influence on the outcome.

**Table 1** Comparison of apical leakage between immediate and delayed post space preparation in AH Plus.

	Apical leakage (mm)		Mann Whitney U test value	P value
	Immediate post space	Delayed post space		
Mean ± SD	0.45 ± 0.24	1.08 ± 0.25	9.500	0.000 (< 0.001), Sig. Diff
Min-Max	0.18-1.04	0.73-1.80		

**Table 2** Comparison of sealing efficacy of AH Plus sealer with that of Apexit Plus sealer after immediate post space preparation.

	Apical leakage (mm)		Mann Whitney U test value	P value
	AH Plus	Apexit Plus		
Mean ± SD	0.45 ± 0.24	1.41 ± 0.31	3.500	0.000 (< 0.001), Sig. Diff
Min-Max	0.18-1.04	0.82-1.80		



**Graph 2** Comparison of sealing efficacy of AH Plus sealer with that of Apexit Plus sealer after immediate post space preparation.

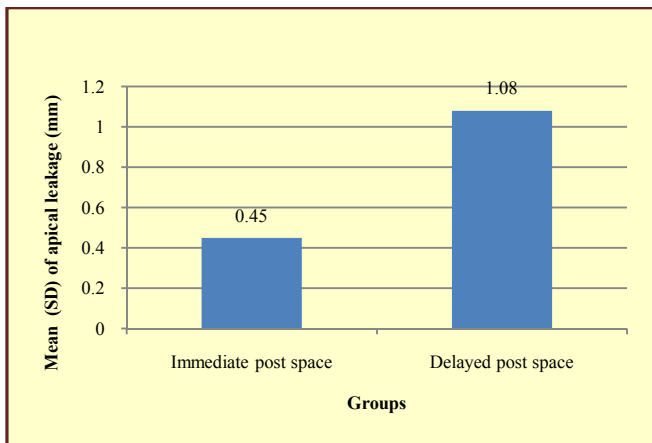
In Apexit Plus immediate post space apical leakage was significantly higher than delayed post space apical leakage. (MW = 51.500, P < 0.05). Apical leakage in Apexit Plus sealer was significantly higher than AH plus after immediate post space preparation. (MW = 3.5, P < 0.001). No statistically significant result was found between the two obturating materials for delayed post space apical leakage.

**DISCUSSION**

Three dimensional sealing of the root canal is one of the main goals of the endodontic treatment and is essential for preventing apical and coronal leakage in the root canal system.

Different methods, including heated instruments, Gates Glidden drills, passo reamers, hand instruments, and solvents in combination with these instruments, have been used to remove the gutta percha in preparation of the post space.<sup>42</sup> During preparation of a post space with rotary instruments, for removing the gutta percha, the possibility exists of twisting the entire filling or creating vibrations and breaking the seal. The hot plugger method has benefits in terms of efficiency and safety. Preparing the post space in combination with rotary instruments reduces the risk of perforation and will not disrupt the integrity of apical seal.<sup>43</sup> Metzger et al demonstrated the sealing to be proportional to the length of the remaining root canal filling. Five millimetres of obturation material is considered as a safe margin.<sup>42</sup> Apical leakage is considered to be the common cause of endodontic failure. Various materials have been used in the root canal treatment in an attempt to achieve success; but the combination of gutta percha and sealer is used commonly. Gutta percha is considered an impermeable core material therefore leakage through an obturated root canal is expected to take place at the interfaces between the sealer and dentin or the sealer and gutta percha or through voids within the sealer. In this in-vitro study, the effect of immediate versus delayed post space preparation on the apical seal using Resin based sealer (AH plus) and Calcium hydroxide based sealer (Apexit Plus) was tested.

The leakage was checked using methylene blue dye as it allows quantitative measurement of the extent of dye penetration by linear measurement techniques.<sup>40</sup> With regard to dyes; particle molecule size, pH and chemical reactivity are expected to affect the degree of penetration. A large number of studies used methylene blue as dye for the study because it is easy to



**Graph 1** Mean and standard deviation (SD) of apical leakage in immediate and delayed post space preparation in AH Plus.

manipulate, has a high degree of staining and a molecular weight even lower than that of bacterial toxins.<sup>41</sup>

In this study, the post space preparation was done using passo reamers and hot pluggers in combination. 5 millimetres of gutta percha was left apically. The leakage was checked from the apical to coronal direction.

In the present study, immediate post space preparation was done using AH Plus sealer which showed the least amount of dye penetration (mean  $\pm$  SD leakage values  $0.45 \pm 0.24$  mm) when compared to the immediate post space preparation with Apexit Plus (mean  $\pm$  SD leakage values  $1.41 \pm 0.31$  mm) (Table 1,2 & Graph 1,2). The results of this study were in agreement with those of Fernando Solano<sup>7</sup>, Gulsat Gungor<sup>42</sup>, Shalin Desai<sup>2</sup>, Neha Dhaded<sup>3</sup>, Priyank Kaushal Kalra<sup>19</sup> and Suran Pushpa<sup>37</sup>, who concluded that AH Plus showed significantly less leakage when the post space is created immediately during obturation. One possible hypothesis is that when the post space is made at the time of obturation itself, the sealer has not yet formed a lasting bond to the gutta-percha or canal wall. When the heated instrument or the rotary instrument is introduced into the canal to remove the gutta-percha, the sealer still is within its working time and allows the sealer to set without introducing microfractures where the sealer is in contact with the gutta-percha and the root canal wall.<sup>5, 7, 19, 37, 42</sup>

The second possible reason could be the dimensional changes of the material upon setting. All epoxy based materials show some expansion after setting. AH Plus expanded up to 0.4% and depicted a slight but continuous expansion in a study by Orstavik D et al, 2001.<sup>19,44</sup>

The uninterrupted setting of the sealer may occur followed by its slight expansion that is achieved when the post space is prepared immediately after obturation. This may also contribute towards the observations of low amounts of dye penetration in the groups with immediate post space preparation.<sup>19</sup>

## CONCLUSION

Sealers are very important component of the gutta-percha root canal filling. Great care must be taken for the selection of materials and the understanding of what each material may contribute to a disease process.

Both the sealers used in this study showed leakage. A few reports by Madison and Zakariasen and Abromovitz et al<sup>42</sup> stated that there were no statistically significant differences between immediate versus delayed post space preparations. However, the present results of this study from the gutta-percha and AH Plus as well as gutta-percha and Apexit Plus groups are in disagreement with the results of those studies. This discrepancy may be due to the timing and methods of post space preparation, operator's skills with regards to maintaining the apical seal during post space preparation and physicochemical properties of the materials used.

With the help of the results of our present study, we can safely conclude that the time of post space preparation has a strong influence on the outcome and is probably a good indicator of success or failure of the post-endodontic treatment.

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