

## RESEARCH

# The Cleaning Efficacy of Passive Ultrasonic Irrigation and XP-Endo Finisher After Post Space Preparation

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### ABSTRACT

#### The Cleaning Efficacy of Passive Ultrasonic Irrigation and XP-Endo Finisher After Post Space Preparation

**Background:** This study aimed to evaluate the efficacy of passive ultrasonic irrigation and XP-Endo Finisher on the cleanliness of canal wall surface after post-space preparation.

**Methods:** Forty endodontically treated mandibular premolar teeth were used. After post-space preparation, the teeth were divided into 4 groups. Irrigation protocols were performed as follows; distilled water as a control group (Group 1), NaOCl/EDTA without any activation (Group 2), NaOCl/EDTA irrigation with passive ultrasonic activation (Group 3), and NaOCl/EDTA irrigation with XP-Endo Finisher (Group 4). The teeth were split and the canal walls were examined with scanning electron microscope under 1000× magnification. The presence of debris was evaluated with 3-point scoring system. For each sample 10 scores were obtained and averaged. The results were statistically analyzed.

**Results:** None of the techniques cleaned the root canal walls completely after post-space preparation. Passive ultrasonic irrigation and XP-Endo Finisher groups demonstrated lower scores than the control and non-activated NaOCl/EDTA groups. The highest results were recorded in the control group.

**Conclusion:** The activation with passive ultrasonic irrigation or XP-Endo Finisher was more effective in cleaning of the root canal walls after post-space preparation.

### KEYWORDS

Irrigation activation, Passive ultrasonic irrigation, Post-space

### ÖZ

#### Pasif Ultrasonik İrrigasyon Ve XP-Endo Finisher'in Post Boşluğu Oluşturulmasından Sonraki Temizleme Etkinliği

**Amaç:** Bu çalışmanın amacı pasif ultrasonik irrigasyon ve XP-Endo Finisher'in post boşluğu hazırlanması sonrasında kök kanal duvarlarının yüzey temizliği üzerindeki etkinliğini değerlendirmektir.

**Gereç ve Yöntemler:** Kırk adet çekilmiş ve kök kanal tedavisi yapılmış diş kullanıldı. Post boşluğu hazırlandıktan sonra dişler dört gruba ayrıldı. Post boşluğuna farklı irrigasyon aktivasyon protokolleri aşağıdaki gibi gerçekleştirildi; kontrol grubu olarak distile su kullanıldı (Grup 1), aktivasyon yapılmadan NaOCl / EDTA irrigasyonu yapıldı (Grup 2), pasif ultrasonik aktivasyon ile NaOCl / EDTA irrigasyonu yapıldı (Grup 3) ve XP-Endo Finisher ile NaOCl / EDTA irrigasyonu yapıldı (Grup 4). Kökler ikiye ayrıldı ve kanal duvarları 1000× büyütme altında taramalı elektron mikroskobu ile incelendi. Smear tabakası varlığı üçlü skorlama sistemi ile değerlendirildi. Her örnek için 10 ölçüm elde edildi ve bu ölçümlerin ortalaması alındı. Sonuçlar istatistiksel olarak analiz edildi.

**Bulgular:** Post boşluğu hazırlandıktan sonra irrigasyon protokollerinin hiçbiri kanal duvarlarını tamamen temizlemedi. Pasif ultrasonik irrigasyon ve XP-Endo Finisher grupları kontrol ve aktivasyon yapılmayan NaOCl / EDTA gruplarından daha düşük skorlar gösterdi. En yüksek sonuçlar kontrol grubunda izlendi.

**Sonuç:** Pasif ultrasonik irrigasyon veya XP-Endo Finisher egesi ile aktivasyon, post boşluğu hazırlanması sonrasında kök kanal duvarlarının temizliğinde daha etkili bulunmuştur.

### ANAHTAR KELİMELER

İrrigasyon aktivasyonu, Pasif ultrasonik irrigasyon, Post boşluğu

Fiber posts are widely used for the restoration of extensively damaged tooth to regain functional and esthetic requirements.<sup>1</sup> The bonding of resin cement with both dentin and fiber posts are important factors for the survival of restorations. Failure in fiber posts usually occur by debonding on the resin cement and root dentin.<sup>2</sup> During the preparation of post-space, smear layer occurs which may consist of solid filling material and sealer remnants. Smear layer covers the dentin surface in post-space and has an adverse effect on bonding at the adhesive resin cement and dentin interface.<sup>2,3</sup> Thus, these remnants on root canal walls must be removed effectively before cementation

cementation of fiber posts to achieve the micromechanical retention of adhesive cements.

Rotary instruments or post drills are generally used to remove the bulk root canal filling to obtain an adequate space for the post.<sup>4</sup> After the removal, irrigation of the post-space is recommended for the cleaning of the root canal walls and preventing microbial contamination<sup>5</sup>. Various irrigation solutions including sodium hypochlorite (NaOCl), chlorhexidine, ethylenediaminetetraacetic acid (EDTA), phosphoric acid and peracetic acid were previously used for post-space irrigation.<sup>2,5,6</sup> Previous studies reported that conventional irrigation procedures fail to obtain well-cleaned root canals.<sup>2,5,7</sup>

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Therefore, rinsing post-space with endodontic irrigation solutions may be insufficient and additional irrigation activation systems are required post-space cleaning. Use of passive ultrasonic irrigation has been suggested as an additional irrigation activation procedure to remove residual root canal filling material smear layer in root canals.<sup>8,9</sup> Another irrigation activation technique, called XP-Endo Finisher instrument has been introduced into endodontic practice to enhance the removal of endodontic filling remnants and smear layer.<sup>9,10</sup> To date, the cleaning efficacy of PUI and XPF has been investigated, but limited data is available about the efficacy of these irrigation activation techniques after post-space preparation.

This study aimed to investigate the effects of passive ultrasonic irrigation and XP-Endo Finisher activation on smear layer removal after post-space preparation.

## MATERIALS AND METHODS

### Sample selection and root canal treatment

Forty extracted mandibular premolar teeth were selected. All teeth were analyzed by digital radiography (MyRay, Imola, Italy) from buccal and proximal directions to determine the presence of a single root canal and examined under magnifications for having no cracks or root resorption. The soft tissue remnants on the external root surface were removed mechanically. The coronal parts of the teeth were sectioned at 14 mm from the apex to obtain a 13 mm working length (WL) for standardization. Root canal preparations were performed by the same operator with ProTaper Universal nickel titanium (NiTi) rotary files (Dentsply Maillefer, Baillagues, Switzerland) to size F3. The root canals were irrigated with 2 ml 5.25% NaOCl between instrument changes. The final irrigation was performed with 5 ml of 17% EDTA and 5 ml of 5.25% NaOCl, and the canals were dried. Then, the root canals were obturated with gutta-percha and root canal sealer (AH Plus, Dentsply, DeTreyGmbH) using single cone technique. One mm cervical part of the filling was removed and the cavity was sealed with resin filling. The samples were stored for two weeks at 37°C and in 100% humidity for the setting of the root canal sealer.

### Post-space preparation and experimental groups

After the storage period, root canal filling was removed with a drill of the post system to a depth of 10 mm for creating post-space. Then the specimens were divided into four groups according to the cleaning procedures;

Group 1: The root canals were irrigated with distilled water for 1 min and served as controls.

Group 2: The root canals were irrigated with 5.25% NaOCl and 17% EDTA, for 1 min and 5 ml for each

solution. The canals were finally irrigated with distilled water for 1 min.

Group 3: The root canal irrigation was performed as in group 2. Additionally, passive ultrasonic irrigation (PUI) was applied during NaOCl and EDTA irrigation. The PUI was performed using an ultrasonic tip (IRRS Smooth wire, VDW GmbH, Munich, Germany) and ultrasonic device (VDW Ultra, VDW GmbH, Munich, Germany) for totally 2 minutes. The ultrasonic tip was placed into post-space and activated with slow up and down movements. The canals were finally irrigated with distilled water for 1 min.

Group 4: The root canal irrigation was performed as in group 2. Additionally, the XP-Endo Finisher (FKG Dentaire, La Chaux-de-Fonds, Switzerland) was operated in the canal during NaOCl and EDTA irrigation at 800 rpm and 1 Ncm up with slow up and down movements for totally 2 minutes. Irrigation activation was performed in water tank warmed at 37 °C. The canals were finally irrigated with distilled water for 1 min.

### Scanning electron microscopy evaluation (SEM)

The buccal and lingual surface grooves were prepared with a low speed diamond disk without perforating the root canals. One half of each root was placed to the scanning electron microscope (SEM) (Quanta™ 450 FEG, FEI, Oregon, USA) and images were taken from root canals at 1000x magnification. For each sample 10 images were taken from different point of the root canal and scored according to the amount of debris using scoring system described by Serafino et al.<sup>11</sup>; Score 0: no debris. Score 1: debris with a diameter between 0-20  $\mu\text{m}$ . Score 2: debris with a diameter  $>20 \mu\text{m}$ . Then, the average score values were calculated for each sample.

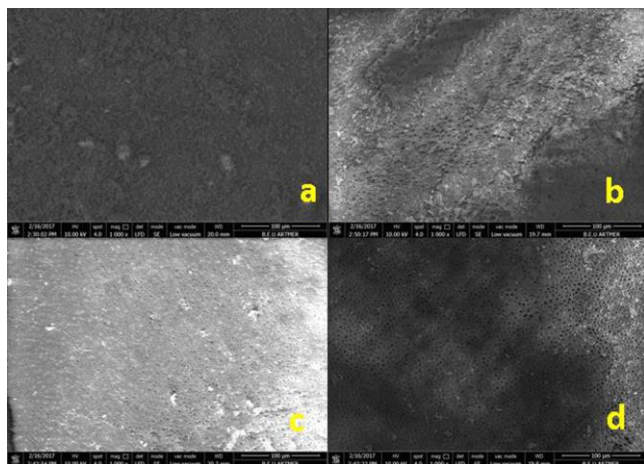
### Statistical Analysis

Statistical analysis of data was performed using SPSS version 19.0 software (SPSS Inc, Chicago, IL, USA). The Shapiro-Wilk test was used for testing of normality. One-way ANOVA and Tukey tests were used for the comparison among the groups.  $P < .05$  was assumed as a significant difference.

## RESULTS

Representative SEM images regarding to different groups are presented in Figure 1. None of the samples demonstrated the removal of filling,

completely. Mean, standard deviations, minimum and maximum values of the all experimental groups are given in Table 1.



**Figure 1**

Representative SEM images regarding to different groups

**Table 1.**

**Gender distribution of CBCT radiographic classifications for left lower third molar teeth (38)**

Group	N	Mean	Std Dev.	Min	Max.
Control	10	2 <sup>a</sup>	-	2	2
NaOCl/EDTA	10	1.71 <sup>b</sup>	0.12	1.50	1.90
PUI	10	1.35 <sup>c</sup>	0.33	0.90	1.90
XP-endo Finisher	10	1.27 <sup>c</sup>	0.26	0.90	1.60

All samples in Group 1 showed score 2 value and this group was significantly different from the experimental groups ( $P < .05$ ). Also, Group 2 was statistically different from Groups 3 and 4 ( $P < .05$ ). Group 2, showed significantly higher scores than the Group 3 and Group 4 ( $P < .05$ ). No significant difference was recorded between Group 3 and Group 4 ( $P > .05$ ).

## DISCUSSION

During the post-space preparation, Gates Glidden instruments or drills cause remnant accumulation on the post-space surface. In addition to classical smear layer, these remnants contain endodontic cement debris. Smear layer removal and strong resin tag formation are the crucial factors for the effective bonding between dentin and adhesive cement in fiber post restoration.<sup>12,13</sup>

Previous studies reported the difficulty of completely removal of the root canal filling material.<sup>14,15</sup> Therefore, supplementary techniques are needed to increase the cleaning of the root canals. The same challenges exist after the removal of filling material during space preparation. According to the current

results, the dentin tubules were not completely visible under SEM evaluation in none of the groups.

Based on the results of the present study, the control group that was irrigated with distilled water has higher scores than the experimental groups that were irrigated with 17% EDTA and 5.25% NaOCl. The combination of EDTA and NaOCl showed lower score values than the distilled water due to the efficacy of EDTA to remove the smear layer and open the dentinal tubules. This finding is consistent with previous studies.<sup>2,6,7,16</sup>

Recently, an instrument called XP-Endo Finisher was introduced for an irrigation activation to enhance the efficacy of the root canal irrigant. A non-tapered with size 25 tip instrument was developed with max wire technology. The shape of the file changes according to the temperature. The straight form at room temperature becomes spoon shape in body temperature. During the rotation, the spoon shape of the file allows contact with root canal walls and improves the root canal cleaning.<sup>15,17</sup>

Another irrigation activation technique, passive ultrasonic irrigation activation is based on acoustic energy transmission of ultrasonic vibrating file to an irrigation solution. These transmitted ultrasonic waves produce acoustic streaming and cavitation effect in irrigation solution that enable debridement of smear layer or remnants.<sup>18</sup> There are many studies in which both smear layer and residual root canal filling materials are removed by passive ultrasonic irrigation activation during endodontic treatments.<sup>18-20</sup>

In current study, both activation techniques provided an additional effect on smear layer removal from the post-space. The smear layer containing the residual root canal filling formed during the post cavity preparation is similar to the smear layer formed during the orthograde retreatment. Therefore, similar results have been observed with previous studies which investigated removal of residual root canal filling. However, some studies claimed that ultrasonic demonstrated similar activity with needle irrigation at post-space.<sup>7,21,22</sup> The different findings could be related to variations in experimental designs and the non-standardized post-spaces sizes.

In the present study, XP-Endo Finisher irrigation activation removed the debris more effectively compared to control group and conventional irrigation group in the post-space. Initial *in vitro* studies demonstrated that the XP-Endo Finisher file was able to remove the smear layer from the root canal and exhibit similar activity to PUI.<sup>9,17</sup> Current study showed that, similarly, no difference was found between the XP-Endo Finisher and passive

ultrasonic activation in terms of smear layer removal at SEM evaluation.

### **CONCLUSION**

The passive ultrasonic irrigation or XP-Endo Finisher showed similar effectiveness in the removal of smear layer. Both activation techniques improved the cleanliness of the post-space. However, none of them completely cleaned the canal walls after post preparation.

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