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Comparison of EndoVac, CanalBrush, EndoActivator and Syringe Irrigation on Removal of Triple Antibiotic Paste

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Abstract:*The aim of this study was to compare the efficacy of different irrigation techniques in the removal of triple antibiotic paste (TAP) from root canal walls.Root canal preparations was performed up to size #30 on 46 extracted single-rooted teeth using ProTaper Next rotary instruments. The root canals were filled with TAP medicament, and after 21 days, the roots were randomly assigned to 4 groups (n = 10) according to the irrigation procedures used: syringe irrigation (SI), CanalBrush, EndoVac, and EndoActivator. In 3 teeth, TAP was not removed (positive controls), and another 3 teeth were not filled with TAP (negative controls). The roots were sectioned longitudinally, and the amount of remaining medicament at each root half (n = 20) was evaluated at x30 magnification using a 4-grade scoring system. The data were analyzed statistically using Kruskal–Wallis and Mann–Whitney U tests.CB and EA gropus were significantly more efficient than SI and EV groups in removing TAP from the root canal (P < 0.05). EV group was better than SI group but it was not significant. Also EA group was the most efficient among all the other groups. At the apical, middle and coronal thirds the results were similar, EA group was the most and SI group was the least efficient in removing TAP from root canals. The use of activation during irrigation significantly improves the removal of TAP from the root canals. However none of these techniques were able to completely remove TAP from root canals.*

Keywords:*CanalBrush, EndoActivator, EndoVac, Triple Antibiotic Paste.*

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I. Introduction

The primary goal of endodontic therapy is to eliminate bacteria and their by-products from the root canal system [1]. While chemomechanical preparation of root canals is effective in reducing bacterial counts, the use of interappointment medicaments to further disinfect the root canal systemhas been advocated to enhance the therapeutic success [2]. Calcium hydroxide (CH) has been widely used as an intracanal medicament owing to its antimicrobial properties against a vast majority of endodontically relevant pathogens [3, 4]. Among several medicaments proposed as an alternative to CH, a triple antibiotic paste (TAP) containing metronidazole, ciprofloxacin, and minocycline has been utilized to disinfect the root canal during regenerative endodontic procedures [5, 6].

Triple antibiotic paste (TAP) was developed by Hoshino et al. [7]. Several reports have indicated that TAP has good antimicrobial properties [7-9]. Several cases, which did not respond to root canal treatment including calcium hydroxide application, were successfully treated with TAP [10, 11]. These studies explain the popularity of TAP in regenerative endodontic procedures and intracanal medication. Ruparel et al. [12] reported that TAP had a detrimental effect on human stem cells in the apical papilla. Thus, this paste should be removed completely from root canals to inhibit its detrimental effects on stem cells. Likewise, TAP should be removed to avoid an effect on sealer penetration and tooth discolouration [13].

Sodium hypochlorite (NaOCl) irrigation solutions are commonly used for the removal of TAP with traditional syringe irrigation techniques [12-15]. However, this is insufficient for complete cleaning of the complex anatomy of the root canal system [16]. Different devices for irrigation delivery have been recommended to increase the flow and distribution of irrigating solutions within the root canal system [17].

The EndoVac System (EV) (Discus Dental, Culver City, CA) is an apical negative pressure irrigation device that is designed to drain irrigation solution at the apical third level of the canal system and to remove debris via a negative pressure mechanism [18]. The EndoActivator System (EA) (Dentsply, Tulsa, OK) is a sonically driven irrigant activation system designed to produce vigorous intracanal fluid agitation that has been shown to increase the efficacy of irrigation better than traditional syringe irrigation [19]. The CanalBrush (CB, Roeko CanalBrush; Coltene/Whaledent, Langenau, Germany), an endodontic microbrush, is used manually with a rotary action. This highly flexible microbrush is molded entirely from polypropylene and has been found to be more efficient when operated at 600 rpm by using a contra-angle handpiece [20].

Various irrigating solutions have been used to remove TAP, but information is limited on this issue

[14, 15, 21]. Therefore, the current study evaluated the effect of various irrigation protocols on the removal of TAP from root canal walls.

II. Material And Methods

Fourty-six single-rooted, noncarious human teeth with similar sizes and completed apices were selected. Soft tissues and calculus were removed mechanically from the root surfaces with a periodontal scaler. Buccolingual and mesiodistal radiographs were taken from the specimens to evaluate their anatomy. The teeth were verified radiographically as having a single root canal. The teeth were then stored in 4°C distilled water until used. Specimens were decoronated with a diamond disc under water coolant to obtain a standardized root length of 14 mm.The root canals were prepared using ProTaper Next rotary instruments (Dentsply-Maillefer, Ballaigues, Switzerland) up to master apical file F4 (size 40, taper 0.06) with 2mL 5.25% sodium hypochlorite (NaOCl) between each file size. Prepared root canals were irrigated with 5mL NaOCl, followed by 5mL 17% EDTA, to remove the smear layer. The canals were subsequently dried with paper points. TAP was prepared by mixing equal portions of metronidazole (Eczacibasi), ciprofloxacin (Biofarma), and minocycline (Ratiopharm, Ulm, Germany) with distilled water (powder/liquid ratio of 3:1).

TAP was applied to the canal spaces with a lentulo spiral until the medicament was visible at the apical foramen. Access to the root canals was temporarily sealed with a cotton pellet and Cavit (ESPE, Seefeld, Germany), and the teeth were stored at 37°C with 100% humidity for 21 days. To simulate clinical conditions, the apices were sealed with hot glue. The specimens were randomly divided into 4 groups (n = 10) according to the irrigation protocols used: syringe irrigation (SI), CanalBrush (CB), EndoVac (EV) and EndoActivator (EA). In 3 teeth, TAP was not removed (positive controls), and another 3 teeth were not filled with TAP (negative controls).In syringe irrigation group, 10 mL 1% NaOCl via a size 27-G double side-vented needle (Ultradent, South Jordan, UT) was used for 60 seconds. The needle was inserted into the root canal within 2 mm of the working length without binding. The flow rate of the irrigating solution was 0.1 mL/s. In CanalBrush group, agitation of 10 mL 1% NaOCl was accomplished by using a CB with a tip diameter of 0.30 mm in a handpiece set at 600 rpm. NaOCl was agitated with the CB for 1 min in a gentle up-and-down motion at 1mm from the WL. In EndoVac group, the canals were first irrigated for 30 seconds with 5 mL 1% NaOCl using macrocannulas. The microcannulas were then inserted to the full working length, and the canals were irrigated with 5 mL 1% NaOCl for 30 seconds. In EndoActivator group, 10 mL 1% NaOCl was flushed into the canal using a 27-G syringe and activated using an EA handpiece set at 10,000 cycles per minute with a red (25/04) tip inserted 2 mm short of the working length for 1 minute.

After the final irrigation, 3 mL distilled water was used to remove any remaining NaOCl. The canals were dried with paper points, and longitudinal grooves were prepared on the buccal and lingual surfaces of each root with a diamond disk without penetrating the canal. The roots were sectioned into 2 halves by a spatula. The amount of remaining TAP at each root half (n = 20) was evaluated. Images of the coronal, middle, and apical thirds of the root canal surfaces were acquired by using a stereomicroscope (Leica MZ75, Meyer Instruments, Langham Creek, Houston) at 30x magnification and transferred to the computer. The amount of TAP remaining in the canal was scored using a 4-grade scoring system described by Van Der Sluis et al [22]: score 0, the canal was empty; score 1, TAP was present in less than half of the canal; score 2, TAP covered more than half of the canal; and score 3, the canal was completely filled with TAP (Fig 1).The differences in the scores of antibiotic pastes among the different groups were analyzed with the Kruskal-Wallis and Mann-Whitney U tests. Testing was performed at the 95% confidence level ($p < 0.05$). All statistical analyses were performed using SPSS software (IBM SPSS Inc, Chicago, IL).

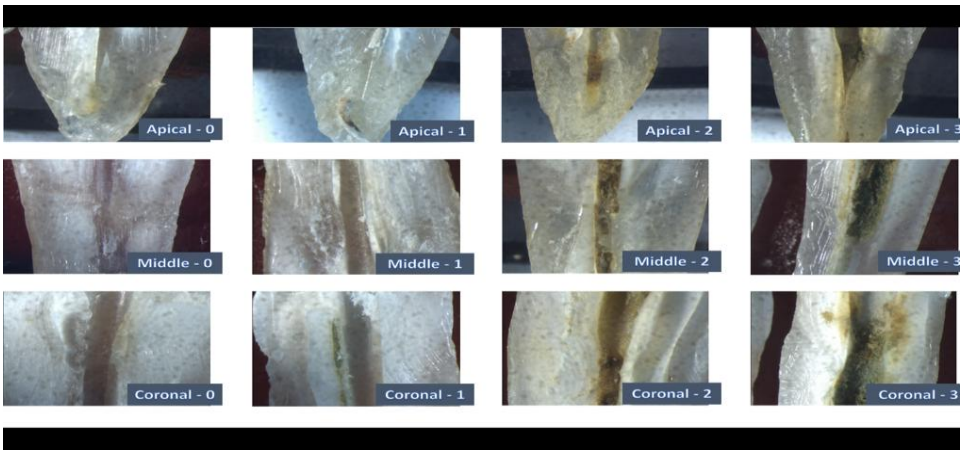

Figure 1: Representative images of scores for TAP

III. Results

Table 1 summarizes the scores for the TAP remaining in the canals for all groups. The positive control group showed that the canal walls were completely filled with TAP, and the negative control group showed no TAP on the canal walls. None of the groups showed complete removal of TAP from the root canals walls. CB and EA gropus were significantly more efficient than SI and EV groups in removing TAP from the root canal ($P < 0.05$). In EV group better results were obtained than SI group but it was not significant. Also EA group was the most efficient in removing TAP from the root canal walls among all the other groups ($P < 0.05$). When the thirds were compared for each group, at the apical, middle and coronal thirds the results were similar. Although the mean rank of the values observed in the apical thirds was superior to those observed in the coronal thirds, there was no statistically significant difference between them ($p > 0.05$). EA group was the most and SI group was the least efficient in removing TAP from root canals.

Table 1: Distribution of Scores for the Removal of Triple Antibiotic Paste

	SI	CB	EV	EA
Coronal	2,52±0,66	1,07±0,72	2,13±0,54	0,33±0,52
Middle	2,15±0,55	1,13±0,61	2,05±0,59	0,52±0,54
Apical	2,21±0,59	0,73±0,59	1,82±0,64	0,52±0,61
Total	2,29±0,53	0,98±0,58	2,00±0,54	0,46±0,52

Kruskal-Wallis Test $p < 0.05$

IV. Discussion

Because the presence of residual materials on dentin walls could compromise the adhesion, adaptation, and sealing efficacy of root canal sealers, intracanal medicaments should be completely removed from the root canal [23]. Various methods have been used to evaluate residual materials on root canal walls, including stereomicroscopy, scanning electron microscopy, computed tomography, and microcomputed tomography [24-26]. In the present study, the remnants of TAP were evaluated under a stereomicroscope at 30x magnification using a scoring method similar to that used in previous studies [21, 27, 28]. The elimination of bacteria and their byproducts from the root canal system is one of the goals of root canal treatment. Thus, the combination of the instrumentation and various irrigation procedures and intracanal medicaments was suggested [3, 29]. Calcium hydroxide has been established as the most frequently used medicament because of its antimicrobial efficacy against most bacterial species identified in endodontic infections [30]. Because infections of the root canal system are considered to be polymicrobial, consisting of both aerobic and anaerobic bacteria species, different antibiotic combinations have also been used [10, 11, 31]. In previous studies it has been shown that TAP can be used clinically in the treatment of teeth with large periradicular lesions and unsuccessfully resected teeth associated with a large periapical lesion [10, 11, 31].

Recently, the use of antibiotic pastes in revascularization cases is popular. After the disinfection procedure with antibiotic pastes, the treatment strategy includes antibiotic paste removal followed by the placement of mineral trioxide aggregate [14, 15]. Likewise, intracanal medicaments should be removed to prevent sealer penetration and tooth discoloration [13]. Thus, these pastes should be removed completely from root canals. However, it is difficult to remove completely antibiotic pastes from the root canal using conventional methods [21]. Therefore, in the present study, CanalBrush, EndoVac and EndoActivator System were used to remove antibiotic pastes from the root canals in comparison with syringe irrigation. The syringe irrigation resulted in the worst scores, which was parallel to the findings of a previous study [21].

Triple antibiotic paste has been left in the rootcanal up to 21 days in root canal treatment and revascularization treatment [14]. In our study, TAP was removed from theroot canal after 21 days also to simulate clinical conditions.Discolorationsafter canal medication with TAP have been reported previously [13, 32]. It was reported that minocycline is the cause of the discoloration [13]. Minocyclinechelates calcium ions to form insoluble complexesthat remain in calcifying tissues [33].In the present study, the previous reports wereconfirmed, as TAP including minocycline discoloredthe root canal walls.The EndoActivator System has previously been compared with other irrigation techniques like manuel irrigation and passive ultrasonic irrigation [24, 34, 35]. It was showedthat the EndoActivator was significantly superior to ultrasonic irrigationin removing debris [34]. In addition, the EndoActivator was found to be moreeffective than ultrasonic irrigation in removing the smear layer [35].In our study, the EndoActivator was found to be superior to all the other irrigation techniques inthe removal of TAP from the canal walls.The EV system has been introducedto solve the air entrapment and irrigant flushing drawbacks at the rootend [18]. In our study, which is consistent with the study of Schoeffel [18], the EV system showed lower scores at the apical third whencompared with the middle and coronal thirds within the EV group. However, it did not showed the best results between all groups.

It was reported that agitation using the CB technique enhanced rootcanal debridement in the apical portions of the root canals [36].Another study found that irrigation activation using the CBtechnique was better than that using the SI technique forremoving calcium hydroxide from the root canals [37]. In this study also, CB

similarly showed better results inthe removal of TAP from the root canal walls. The increased capability of the CB technique to remove debris may be explained by the fact that the brush used inthis technique maintained contact with the narrowerparts of the root canal surfaces than did the other irrigation techniques.

V. Conclusion

According to the findings of the present study, it can be concluded that the use of irrigation activation protocols significantly improved the removal of TAP from the root canal walls when compared with SI. However, none of the tested techniques completely removed TAP from the root canals walls. Our findings indicate the effectiveness of EA and CB in the removal of TAP from the root canals. Further research is needed to identify techniques and irrigants that can completely remove TAP from the root canal system.

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