Comparison of Sealer Penetration Using the EndoVac Irrigation System and Conventional Needle Root Canal Irrigation

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Abstract

Introduction: The aim of this study was to compare the effect of the EndoVac irrigation system (SybronEndo, Orange, CA) and conventional endodontic needle irrigation on sealer penetration into dentinal tubules. **Methods:** Forty single-rooted, recently extracted human maxillary central incisors were randomly divided into 2 groups according to the irrigation technique used: conventional endodontic needle irrigation and EndoVac irrigation. All teeth were instrumented using the ProFile rotary system (Dentsply Maillefer, Ballaigues, Switzerland) and obturated with gutta-percha and AH Plus sealer (Dentsply DeTrey, Konstanz, Germany) labeled with fluorescent dye. Transverse sections at 1, 3, and 5 mm from the root apex were examined using confocal laser scanning microscopy. The total percentage and maximum depth of sealer penetration were then measured. **Results:** Mann-Whitney test results showed that EndoVac irrigation resulted in a significantly higher percentage of sealer penetration than conventional irrigation at both the 1- and 3-mm levels ($P < .05$). However, no difference was found at the 5-mm level. The 5-mm sections in each group showed a significantly higher percentage and maximum depth of sealer penetration than did the 1- and 3-mm sections ($P < .05$). **Conclusions:** The EndoVac irrigation system significantly improved the sealer penetration at the 1- to 3-mm level over that of conventional endodontic needle irrigation. *(J Endod 2014;40:613–617)*

Key Words

Confocal laser scanning microscopy, EndoVac, irrigation, sealer penetration

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The main goal of endodontic treatment is to eliminate infection within the root canal system and prevent reinfection. Schilder (1) suggested that successful endodontic therapy can be achieved using mechanical instrumentation and chemical irrigation. Peters et al (2) found that regardless of the instrumentation technique used, 35% or more of the root canal surfaces remained uninstrumented. Because of the complex anatomic features of the root canal such as the lateral canals, isthmuses, and deltas, elimination of all debris and bacteria is impossible (3, 4), particularly in the apical third (5). Therefore, irrigation is an essential part of root canal debridement (6). Chemical irrigation agents such as sodium hypochlorite (NaOCl) and EDTA are able to penetrate these mechanically inaccessible areas (7), killing microorganisms, flushing debris, and removing the smear layer from the root canal system (8).

These irrigants must come in direct contact with the root canal wall for effective action (9). The degree of penetration of irrigants into the apical third of root canals is influenced by many factors, including the final apical preparation size (10), the maintenance of apical patency (4), the volume of irrigant used, the physical and chemical properties of the irrigant, and the presence of a vapor lock (11). Another important factor is the irrigant delivery method. Different irrigation delivery devices and techniques are available. Conventional needle irrigation does not allow the delivery of solutions beyond the tip of the irrigation needle (12). The EndoVac system (SybronEndo, Orange, CA), an apical negative pressure irrigation system, was developed to deliver irrigating solutions to the apical end of the canal system and suction out debris. This system has 3 components: the master delivery tip, which is designed for simultaneous irrigation and evacuation; the macrocannula, which removes coarse debris; and the microcannula, which allows for the removal of debris in the apical region (13). The EndoVac showed better removal of the smear layer in the apical third of the root canal than did needle irrigation (14).

In different studies, the effect of the EndoVac irrigation system on smear layer removal (15, 16), debridement efficacy (17, 18), bacterial elimination (19–21), and postoperative pain (22) have been evaluated. However, the effect of the EndoVac irrigation system on sealer penetration has not been studied. The aim of this study was to compare the effect of the EndoVac irrigation system and conventional endodontic needle irrigation on sealer penetration into dentinal tubules using confocal laser scanning microscopy. The null hypothesis tested was that there is no difference in the percentage and maximum depth of sealer penetration between the EndoVac irrigation system and conventional endodontic needle irrigation.

Materials and Methods

Forty recently extracted human maxillary central incisors with single canals, straight mature roots, and no caries or resorption were used in this study. The presence of a single canal was verified radiographically with 3 angulated radiographs. All experimental procedures were performed by a single operator.

After access cavity preparation with 4 surrounding walls, the working length was established by inserting a size 10 K-file (Mani Inc, Tochigi Ken, Japan) into each root canal up to the apical foramen and then subtracting 1 mm from this length. Root ends of all teeth were dried and sealed with glue to simulate *in vivo* conditions. Teeth were randomly divided into 2 experimental groups of 20 teeth each according to the irrigation technique used: conventional needle irrigation using a 28-G needle (conventional endodontic needle irrigation group) and the EndoVac irrigation system (EndoVac group).

All teeth were instrumented using the ProFile rotary system (Dentsply Maillefer) with the crown-down technique to a size of 40/.04 at the working length. To ensure patency, recapitulation to the working length was accomplished after each rotary instrument series using a size 10 K-file.

In the conventional endodontic needle irrigation group, the root canals were irrigated using a 28-G side-vented needle (Max-i-Probe; Dentsply Rinn, Elgin, IL) and a syringe. The irrigation protocol for this study followed that used by Nielsen and Craig Baumgartner (14). The canals were irrigated with 1 mL 5.25% NaOCl after each instrument, keeping the canal and the pulp chamber full of irrigant at all times. The irrigation needle was placed as deep as possible into the canal without binding to the canal wall but not closer than 2 mm from the working length. After instrumentation to the master apical file size, the canals were finally rinsed with 5.25% NaOCl for 30 seconds followed by rinsing with 17% EDTA and again with 5.25% NaOCl for 30 seconds.

In the EndoVac irrigation group, the master delivery tip of the EndoVac device was placed at the access opening to constantly deliver 5.25% NaOCl solution, filling up the root canal system. NaOCl (1 mL) was used to replenish the irrigant in the pulp chamber after each rotary nickel-titanium instrument, as in the conventional irrigation group. On completion of instrumentation to the size of the master apical file, macroirrigation was performed using 5.25% NaOCl with the macrocannula constantly moving up and down in the canal from the point where it started to bind to a point just below the orifice. This step was accomplished in 30 seconds. NaOCl was then left untouched in the canal for 60 seconds. This rest period was followed by the 3 cycles of microirrigation. Each cycle of microcannular irrigation involved placing the tip at the full working length for 6 seconds, withdrawing 2 mm from the full working length for 6 seconds, and then returning back to the full working length for the next 6 seconds. This up-and-down motion continued until 30 seconds had elapsed. After 30 seconds of irrigation, the microcannula was withdrawn from the canal in the presence of sufficient irrigant in the pulp chamber to ensure that the canal remained totally filled with irrigant and that no air was drawn into the canal space, completing 1 microirrigation cycle. Irrigants were used as follows: first cycle, 5.25% NaOCl; second cycle, 17% EDTA; and the third cycle, 5.25% NaOCl. At the end of the third cycle, the microcannula was left at the working length to remove excess irrigant.

All the canals were dried with absorbent paper points (Diadent Group International Inc, Chongju, Korea) and obturated with AH 26 sealer (Dentsply DeTrey, Konstanz, Germany) and gutta-percha using the lateral compaction technique. For fluorescence under confocal laser scanning microscopy, AH 26 sealer was mixed with 0.1% fluorescent rhodamine B isothiocyanate (Bereket Chemical Industry, Istanbul, Turkey). After the resin had completely set, each tooth was sectioned perpendicular to its long axis in 1-mm-thick sections using a slow-speed, water-cooled 0.3-mm microtome saw (Isomet Buehler) at points 1, 3, and 5 from the root apex. All sections were then polished with silicone carbide abrasive papers.

Confocal Laser Scanning Microscopic Investigation

All specimens were mounted onto glass slides and examined with a Leica TCS-SPE confocal laser scanning microscopy (Leica, Mannheim, Germany). The method used by Gharib et al (23) was applied to evaluate the images. First, each sample image was imported into Photoshop (Adobe Systems, Inc, San Jose, CA). In each sample image, the circumference of the root canal wall was outlined and measured with a Photoshop measuring tool. Next, areas along the canal walls in which the sealer penetrated into dentinal tubules were outlined and measured using the same method. The outlined lengths where sealer had penetrated were divided by the canal circumferences to calculate the percentage of sealer penetration into the canal wall.

Results

The percentage of sealer penetration and the maximum depth of penetration in the tested groups are reported in Figures 1 and 2. Representative pictures from each group are shown in Figure 3.

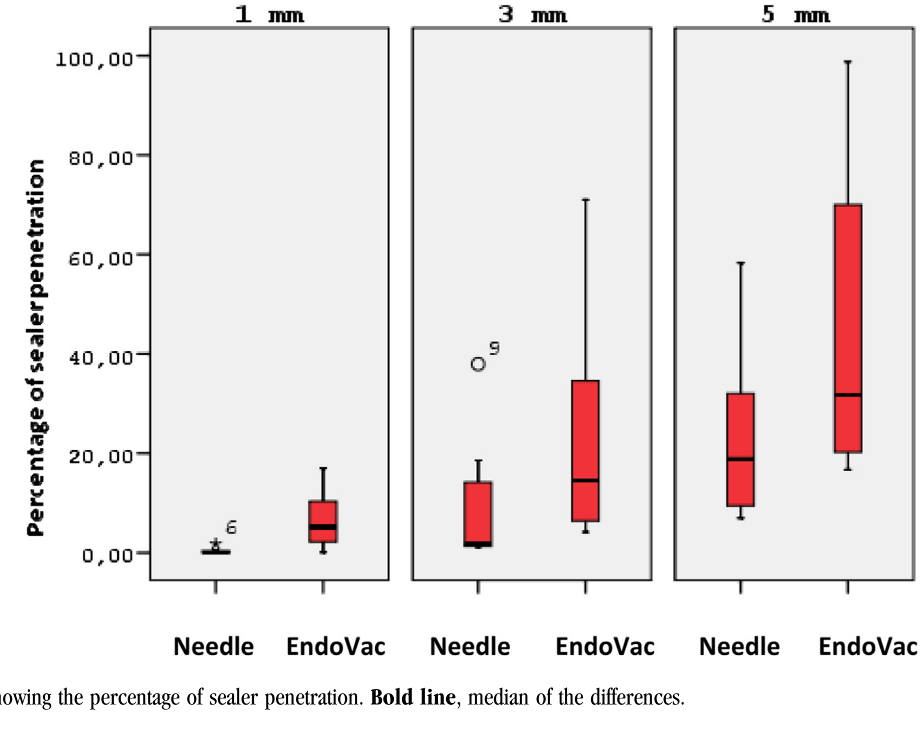

Figure 1. Box plots showing the percentage of sealer penetration. **Bold line**, median of the differences.