Comparison of the EndoVac System to Needle Irrigation of Root Canals

Benjamin A. Nielsen, DMD, and J. Craig Baumgartner, DDS, PhD

Abstract

Past studies have shown that current irrigation methods are effective at cleaning root canals coronally but less effective apically. To be effective, endodontic irrigants should ideally be delivered near working length. The purpose of this study was to compare the efficacy of the EndoVac irrigation system and needle irrigation to debride root canals at 1 and 3 mm from working length. One tooth of each matched pair was instrumented and irrigated by using the EndoVac, which uses negative pressure to deliver irrigating solutions to working length. The other tooth of the matched pair was instrumented and irrigated with a 30-gauge ProRinse irrigating needle. All teeth were irrigated with sodium hypochlorite (NaOCl) and ethylenediaminetetraacetic acid (EDTA) for a predetermined amount of time, and total volume of irrigant used was recorded. After instrumentation and irrigation, the teeth were fixed, decalcified, and sectioned at 1 mm and 3 mm from working length. Serial sections were made and digitally photographed. The amount of remaining debris was determined as a percentage of the area of the canal lumen. Remaining debris and total irrigant were analyzed by using the Wilcoxon signed rank test at the 5% confidence level. At the 1-mm level, significantly less debris was found in the EndoVac group ($p = 0.0347$). At the 3-mm level, there was no significant difference between groups. Significantly more irrigant was delivered with the EndoVac ($p < 0001$). This study showed significantly better debridement at 1 mm from working length by using the EndoVac compared with needle irrigation. *(J Endod 2007;33:xxx)*

Key Words

EndoVac, residual debris, root canal irrigation

From the Oregon Health & Science University, Portland, Oregon.

Address requests for reprints to Dr. J. Craig Baumgartner, Department of Endodontology, 611 Campus Dr, Portland, OR 97239-3097. E-mail address: baumgarc@ohsu.edu.

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Debridement of the root canal system is essential for endodontic success. Irrigation is a vital part of root canal debridement (1). Unfortunately, many studies have shown that currently used chemomechanical methods of root canal preparation do not effectively debride the entire root canal system (2–6). Ideally, root canal irrigants should flush out debris, dissolve organic tissue, kill microbes, destroy microbial by-products, and remove the smear layer. To accomplish these objectives, there must be an effective delivery system to working length. Working length may be defined as the distance from a coronal reference point to where the canal system is cleaned, shaped, and obturated to prevent recurrent infection. An improved delivery system for root canal irrigation is highly desirable. Such a delivery system must have adequate flow and volume of irrigant to working length to be effective in debriding the canal system without forcing the solution into periradicular tissues (3, 7).

The EndoVac system (Discus Dental, Culver City, CA) is a novel new irrigation system. A delivery/evacuation tip is attached to a syringe of irrigant and the high speed suction of the dental chair (Fig. 1A). A small tube attaches either a macro- or microcannula to the suction (Fig. 1B, C). The delivery/evacuation tip places irrigant in the chamber and siphons off the excess to prevent overflow (Fig. 1D). The macrocannula is plastic with an open end that measures International Standards Organization (ISO) size 55 with a .02 taper (Fig. 2B). The microcannula is stainless steel and has 12 small, laterally positioned, offset holes in 4 rows of 3, with a closed end measuring ISO size 32 (Fig. 2A). As these cannulas are placed in the canal, negative pressure pulls irrigant from a fresh supply in the chamber, down the canal to the tip of the cannula, into the cannula, and out through the suction hose. The microcannula can be used at working length in a canal enlarged to ISO size 35 or larger. The purpose of this study is to compare the efficacy of the EndoVac system and needle irrigation to debride the apical 3 mm of a root canal.

Materials and Methods

The Institutional Review Board of the Oregon Health & Science University approved this study. Matched pairs of intact, extracted human incisors, canines, and premolars (with 1 canal or 2 distinct roots) from both arches, verified with radiographs, were used in this study (Fig. 3). Nineteen matched pairs of teeth stored in saline, including 2 maxillary premolars with 2 distinct roots, yielded 21 matched root canals that were selected for this study. The external surfaces of the teeth were debrided with hand scalers. A flat occlusal surface was made as a reference for determining working length, and the pulp chamber of each tooth was accessed. Working length was determined as the point where a #10 file (Tulsa Endodontics, Tulsa, OK) was just visible with ×20 magnification in the apical foramen. Shallow horizontal grooves were made in the coronal one third of each root for mechanical retention. The coronal two thirds of each root was then coated with tray adhesive (Dentsply Caulk, Milford, DE) and the tooth placed in 1-inch segments of surgical tubing (Sullivan-Schein, Melville, NY) filled with polyvinyl siloxane impression material (Dentsply Caulk) (8, 9).

A coin was flipped to determine which tooth of each pair would be cleaned and shaped by using the EndoVac system. The other tooth of the pair was cleaned and shaped by using a conventional irrigation protocol. Each tooth in each pair received an equal amount of time for irrigation. The volume of irrigant used for each method was recorded. The teeth in each pair were cleaned and shaped to the same size by using the same method of canal preparation. Shaping included the use of Gates Glidden drills and profile series 29 .04 taper rotary instruments (Tulsa Endodontics) by using a crown-

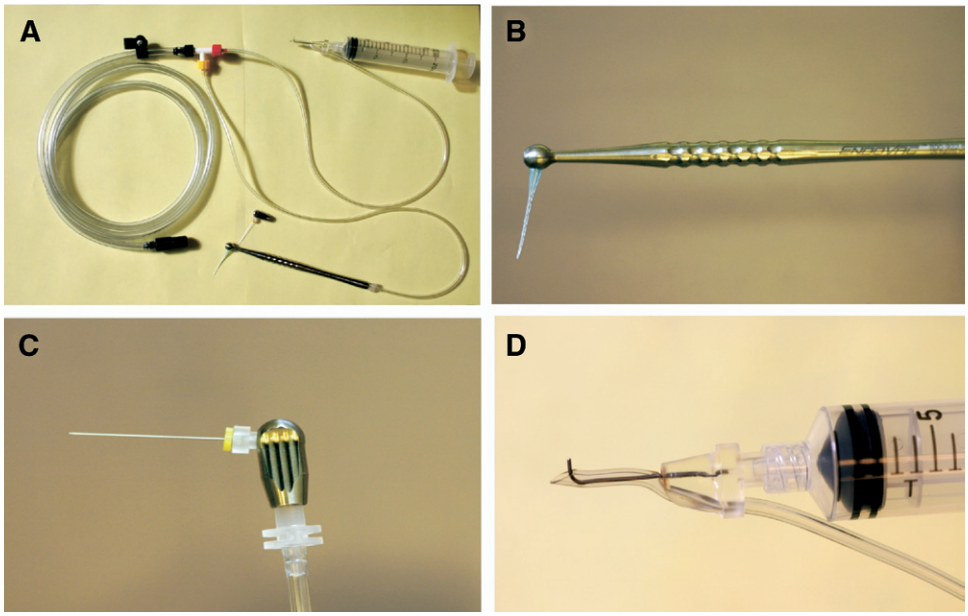

Figure 1. (A) The complete EndoVac system including all tubing and vacuum attachment. The free end of the large tubing plugs into the high speed suction of the dental chair. A clip, seen on the end of the clear tubing near the "T" connector, attaches to the patient napkin. (B) The macrocannula attached to its handle used for initial flushing of the coronal portion of the canal. (C) The microcannula attached to its handle. This replaces the macrocannula and its handle and is used for irrigation at the apical portion of the canal to working length. (D) The delivery/evacuation tip attached to a syringe. Irrigant is delivered to the pulp chamber by the metal needle. Any excess is immediately suctioned off through the plastic tubing surrounding the metal that is attached to the suction tubing.

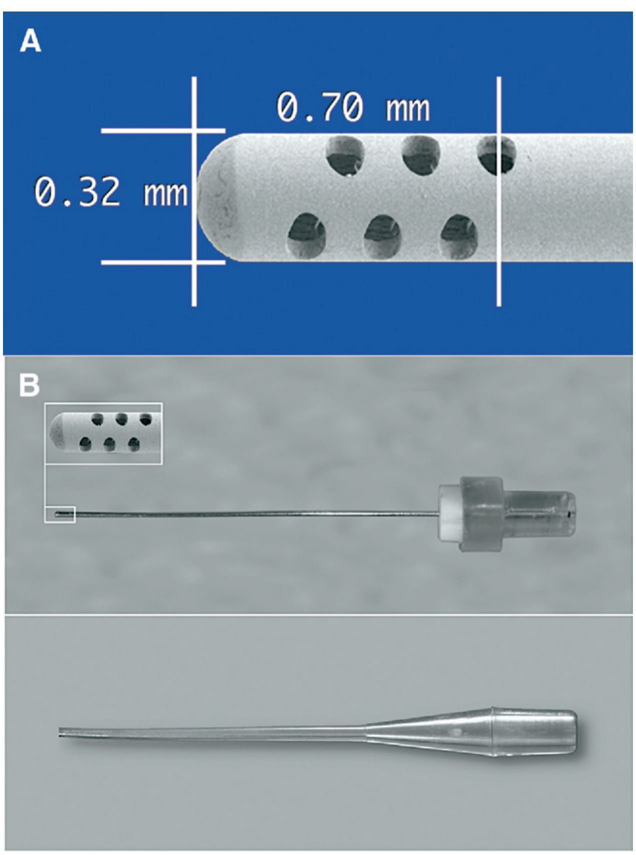

Figure 2. (A) Scanning electron microscope photograph of the microcannula with measurements. (B) Comparison picture of the closed-ended microcannula (ISO size 32) and open-ended macrocannula (ISO size 55). The inset box is a higher magnification of the end of the microcannula. (Photos courtesy of Dr. John Schoeffel.)

down, continuous taper technique (10). To ensure patency, recapitulation to working length was accomplished after each rotary instrument series with a #10 stainless steel hand file (Tulsa Endodontics). The canals were instrumented to a series 29 size 6 (ISO size 36) or larger at working length (Fig. 2A). Matched pairs of teeth were instrumented to the same master apical file size.

Irrigation with the EndoVac began during the use of Gates Glidden drills. While the Gates Glidden drills were being used, the EndoVac delivery/evacuation tip was placed above the access opening to constantly deliver and evacuate 5.25% sodium hypochlorite (NaOCl), keeping the canal and pulp chamber full of irrigant at all times. One milliliter of NaOCl was used to replenish the irrigant in the pulp chamber after each rotary NiTi instrument. After reaching working length with the master apical file, macroirrigation of each canal with NaOCl was accomplished over a 30-second period. This was done by using the EndoVac delivery/evacuation tip while the macrocannula was constantly moved up and down in the canal from a point where it started to bind to a point just below the orifice. The canal space was then left undisturbed, full of irrigant for 60 seconds. Three cycles of microirrigation followed. During a cycle of microirrigation, the pulp chamber was maintained full of irrigant while the microcannula was placed at working length for 6 seconds. The microcannula was then positioned 2 mm from working length for 6 seconds and then moved back to working length for 6 seconds. This up-down motion continued until 30 seconds had elapsed, thus ensuring 18 seconds of active irrigation directly at working length. 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. The canal filled with irrigant was left undisturbed for 60 seconds. This completed one microirrigation cycle. The first cycle used 5.25% NaOCl as the irrigant, the second cycle 15% ethylenediaminetetraacetic acid (EDTA), and the third cycle 5.25% NaOCl. At the end of the third microirrigation cycle, the microcannula was left at working length without replenishment to remove excess fluid.

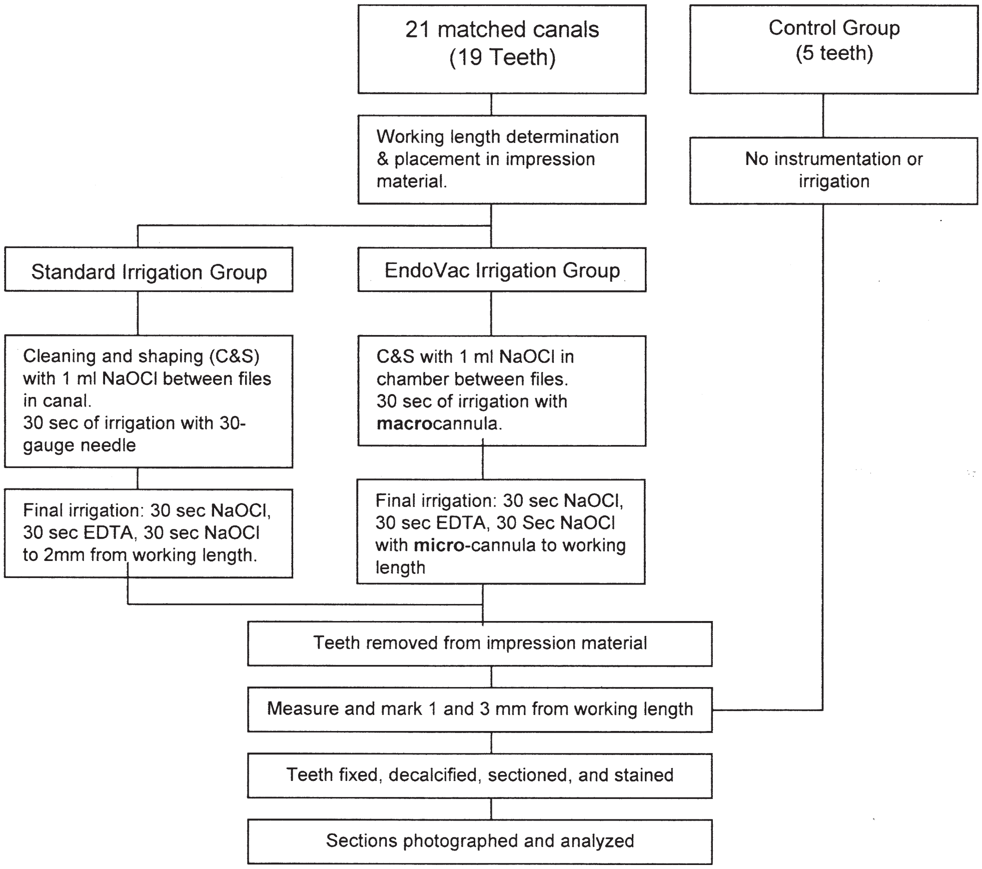

Figure 3. Flowchart of the methodology.

The other tooth of each pair was irrigated by using a 30-gauge ProRinse needle (Tulsa Endodontics) and syringe (11). A 1-mL flush of 5.25% NaOCl, short of the binding point, was used after each instrument, leaving the canal filled with irrigant between instruments. This was done with the needle placed just short of the binding point but no closer than 2 mm from working length. A small (1-2 mm), constant apical-coronal movement of the needle was maintained during expression of irrigant. After instrumentation to the master apical file size, irrigation with NaOCl for 30 seconds was accomplished. The irrigant was then left undisturbed in the canal for 60 seconds. Further irrigation with the needle was performed moving the needle from 2 mm from working length to 4 mm from working length in constant motion for 30 seconds. NaOCl was used and left untouched in a full canal for 60 seconds. This was followed by EDTA for 30 seconds of irrigation and then left undisturbed for 60 seconds. The last irrigant was NaOCl using the same method for the same amount of time. The irrigant was then aspirated from the canal by using the irrigation needle at 2 mm from working length.

A third group of 5 teeth were positive controls. After access preparation, a #10 file was placed to determine the working length. No other instrumentation or irrigation was performed on these teeth. These teeth were fixed, decalcified, and sectioned for microscopic evaluation.

The experimental teeth were removed from the impression material and tubing. A #10 file with a rubber stopper set at working length was then placed on the external surface of the tooth and working length marked with a scalpel. The teeth were marked at 1 and 3 mm from working length with a scalpel. A one-eighth round bur was then used to deepen the marks and make a shallow groove. The teeth were fixed by

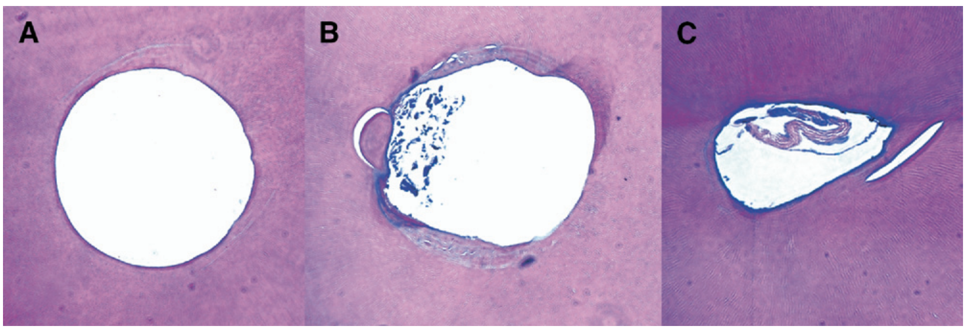

Figure 4. Pictures taken of representative slides at 1 mm from working length with 100× magnification. (A) No debris, (B) moderate debris, and (C) control sample showing moderate to severe debris with no instrumentation of the lumen.

filling each canal with formalin by using a 30-gauge ProRinse needle and then submerging each tooth in formalin for a minimum of 24 hours. The teeth were decalcified in Kristenson's decalcification solution (102 g sodium formate, 1,500 mL hot tap water, 515 m formic acid, and 925 mL cold water) for at least 1 week. Complete decalcification was verified with a radiograph. The decalcified roots were cut with a scalpel at the shallow grooves marking 1 and 3 mm from working length. Six-micron, serial histologic sections were then made from the appropriate end of each root section and stained with hematoxylin and eosin. Each slide contained serial sections of either the 1- or 3-mm level of one of the experimental teeth.

Before viewing the sections, any identification on the slide was masked and the slides randomized. The sections on each glass slide were compared by using a light microscope at 100× magnification. The section containing the greatest amount of canal debris was then digitally photographed (Fig. 4). All images were analyzed by using the Scion Image software program (Scion Corporation, Frederick, MD). The amount of debris left in the canals was quantified as a percentage of the canal lumen area. The data were statistically analyzed to compare the percentage of debris and efficacy of the irrigation techniques between teeth of each matched pair. The Wilcoxon signed rank test was used because of nonparametric data.

Results

Five root sections were lost during processing leaving 18 matched root canals at the 1-mm level and 19 matched root canals at the 3-mm level. However, 21 matched pairs of teeth were analyzed for volume of irrigant used. The root canals prepared by using the EndoVac when compared with needle irrigation did not show any significant difference at the 3-mm level. However, at the 1-mm level, the teeth treated with the EndoVac showed significantly less remaining debris ($p = 0.0347$) (Table 1). The volume of irrigant used with the EndoVac system was significantly more than the needle irrigation group ($p < 0.0001$) (Table 2). One control tooth was lost during processing. The remaining four control teeth showed debris at 1 and 3 mm. All controls showed a lumen that had not been instrumented (Fig. 4).

Discussion

Past studies have shown that current irrigation methods may be effective at cleaning the coronal portions of root canals but much less effective in the apical portions of canals (2, 4, 8, 9, 12–16). In this study, the use of the EndoVac system resulted in statistically significant more debris removal at 1 mm from working length than needle irrigation.

Sodium hypochlorite (NaOCl) has the ability to dissolve organic debris, kill microbes, and destroy microbial byproducts (5, 17, 18). EDTA is a chelating agent used to remove the smear layer (9, 19). This combination of irrigants has been shown to be effective in debriding and disinfecting root canals as well as other irrigants (9, 19–22).

One advantage of the EndoVac system seems to be the ability to safely deliver irrigant to working length. To avoid NaOCl accidents, clinicians must be careful how far the irrigating needle is placed into the canal. Recommendations include not binding the needle in the canal, not placing the needle close to working length, and using a gentle flow rate to avoid accidents with potentially serious consequences (23, 24). With the EndoVac, irrigant is pulled into the canal and removed by negative pressure at working length. A recent study by Fukumoto et al. (25) compared extrusion of irrigant out the apex by using irrigation methods similar to this study. Their method, also using negative pressure, showed less extrusion of irrigant than needle irrigation when both were placed 2 mm from working length. To simulate the clinical situation with a normal irrigation method, the irrigating needle used in this study was placed no closer than 2 mm from working length. Because of the inherent differences between these two irrigating techniques, the variable of cannula or needle compared with working length was not held constant and represents the possible advantage of the EndoVac system, namely, safe irrigation at working length. Two millimeters represents a distance from the working length that is likely the closest that most practitioners place an ordinary needle during irrigation. Thus, this distance is a best-case scenario for needle irrigation to compare with the EndoVac system.

In using the EndoVac, blockage of the microcannula is a concern. One of the main purposes of the macrocannula is to remove as much debris as possible before the smaller microcannula is used, thus reducing material that may clog the microcannula. The chemical action of NaOCl and EDTA may help to dissolve both organic and inorganic debris clogging the holes of the EndoVac. During this study, the holes of the microcannula were checked at ×20 magnification after each root canal was cleaned and shaped. Invariably, some of the holes were at least partially blocked, but with 12 holes, several could be blocked and the system was seen still working effectively by the visualization of fluid moving through the suction tubes. The blocked holes were made patent with a positive pressure rinse, or the cannula was replaced.

The volume of irrigant delivered with the EndoVac system was significantly more than the volume delivered with needle irrigation over the same amount of time (Table 2). With the EndoVac system, more irrigant can be delivered through the delivery/evacuation tip. While the cannulas are in the canal, a constant flow of fresh irrigant is being delivered by negative pressure to working length.

Studies have shown an increased efficacy of canal debridement with increased apical size preparations and increased taper of instruments (8, 15, 26–29). This study showed significantly better debridement 1 mm from working length for the EndoVac system compared with needle irrigation. Future studies should look at the effect of taper, apical size, safety, and effect on apical seal when the EndoVac is used for irrigation.

TABLE 1. The amount of debris at 1 mm and 3 mm from working length

Group	Mean (%)	Standard Deviation	p Value
EndoVac 1 mm	1.565	3.99	0.0347*
Needle 1 mm	5.730	13.65	
EndoVac 3 mm	0.421	0.86	0.1119
Needle 3 mm	2.825	6.26	

*Significant $p < 0.05$.

TABLE 2. Volume of Irrigant Used

	Mean (mL)	Standard Deviation	p Value
EndoVac irrigation	42.214	7.55	<0.0001*
Needle irrigation	15.714	2.43	

*Significant $p < 0.05$.

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