Comparative Safety of Various Intracanal Irrigation Systems

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Abstract

The objective of this project was to evaluate the safety of various intracanal irrigation systems by measuring the apical extrusion of irrigant. Twenty-two single canal, extracted mature teeth were instrumented and secured through the lid of a scintillation vial to collect apically extruded irrigant. A precision syringe pump delivered controlled amounts of irrigant at a constant flow. The irrigation systems used were EndoVac Micro and Macro Cannula, EndoActivator, manual irrigation with Max-I-Probe needle, Ultrasonic Needle Irrigation, and Rinsendo. Results were analyzed by using one-way analysis of variance with Scheffé test ($P < .05$). The EndoVac Micro and Macro cannulae groups did not extrude irrigant, and there was no statistically significant difference between these 2 groups and the EndoActivator group. Within the groups that produced extrusion, EndoActivator extruded statistically significantly less irrigant than Manual, Ultrasonic, and Reinsendo groups. There was no statistically significant difference among Manual, Ultrasonic, and Rinsendo groups. This study showed that the EndoVac did not extrude irrigant after deep intracanal delivery and suctioning the irrigant from the chamber to full working length. EndoActivator had a minimal, although statistically insignificant, amount of irrigant extruded out of the apex when delivering irrigant into the pulp chamber and placing the tip into the canal and initiating the sonic energy of the EndoActivator. Manual, Ultrasonic, and Rinsendo groups had significantly greater amount of extrusion compared with EndoVac and EndoActivator. *(J Endod 2009;35:545–549)*

Key Words

EndoActivator, EndoVac, RinsEndo, safety, ultrasonic needle

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Chemomechanical debridement is an important part of endodontic treatment. Elimination of pulpal tissue, microbiota and their by-products, and organic and inorganic debris removal by using instruments and intracanal irrigants are objectives of this important phase of treatment. Sodium hypochlorite along with ethylenediaminetetraacetic acid is able to achieve the goal of chemical debridement (1, 2). Sodium hypochlorite carries risk of extrusion into periapical tissues causing inflammation, ecchymoses, hematoma, and sometimes even necrosis and paresthesia (3–5). Accordingly, any root canal irrigation delivery system that reduces the risk of sodium hypochlorite extrusion into the periapical tissues would greatly benefit patient care.

In vitro studies have demonstrated that when root canals are instrumented and irrigated with patent apical terminations, extrusion of irrigants beyond the apical constriction is routine (6–9). Accordingly, the premise of this study was to create the worst case scenario for testing the potential of each device to extrude endodontic irrigants: a tooth with a patent apical foramen, not covered by either bone or membrane, and terminating in an atmospheric neutral environment.

The specific aim of this *in vitro* study was to compare the relative safety of various intracanal irrigation systems. The volume of irrigant that extruded beyond the minor diameter of the apical foramen was measured. The device 's safety was then directly correlated to the amount of extruded irrigant. Five irrigation delivery and/or activation systems with different irrigation principles were included in this study.

The EndoVac apical negative pressure irrigation system (Discus Dental, Smart Endodontics, Culver City, CA) has 3 components: Micro cannula (MICRO) (test group 1) (Fig. 1*B*), the Macro cannula (MACRO) (test group 2) (Fig. 1*A*), and the Master Delivery Tip (MDT) (Fig. 1*C-3*). The MDT simultaneously delivers and evacuates the irrigant (Fig. 2). The Macro cannula is used to suction irrigant from the chamber to the coronal and middle segments of the canal. The Micro cannula contains 12 microscopic holes and is capable of evacuating debris to full working length. Nielsen and Baumgartner (10) concluded that EndoVac was significantly better for root canal debridement at the apical termination than positive pressure needle irrigation.

The EndoActivator) (Advanced Endodontics, Santa Barbara CA) (test group 3) (Fig. 1*D-1*) uses sonic energy to irrigate root canal systems. This system has 2 components, a handpiece and activator tips (Yellow 15/02, Red 25/04, Blue 35/04). The battery-operated handpiece activates from 2,000–10,000 cycles/min. The manufacturer recommends using this device after completion of cleaning and shaping and irrigation of the canal with a manual syringe and an endodontic irrigation needle (11). On placing irrigant into the canal and chamber, passively fitting tips are activated at 10,000 cycles/min for 30–60 seconds. It has been reported that sonic irrigation is capable of producing clean canals (12, 13).

Manual irrigation with a side-ported needle (Max-I-Probe; Dentsply International, York, PA) (MAX) by using positive pressure (test group 4) (Fig. 1*C-2*) within 2–3 mm of working length is the most commonly used endodontic irrigation system. Instances of expressing irrigants into periapical tissues and causing significant tissue damage and postoperative pain have been reported with the use of positive pressure (3–5).

A unique Ultrasonic Needle system (UN) capable of delivering and agitating the irrigant simultaneously was used in this study (test group 5) (Fig. 1*C-1*). It has been observed that the needle can produce cavitations with high ultrasonic output in shaped canals by removing pulpal tissues and debris better than hand and rotary instrumentation alone from canals and isthmi (14).

Rinsendo (RE) (Air Techniques Inc, New York, NY) (test group 6) irrigates the canal by using pressure-suction technology. Its components are a handpiece, a cannula with a 7-mm-long exit aperture, and a syringe carrying irrigant (Fig. 1*D-2*). The

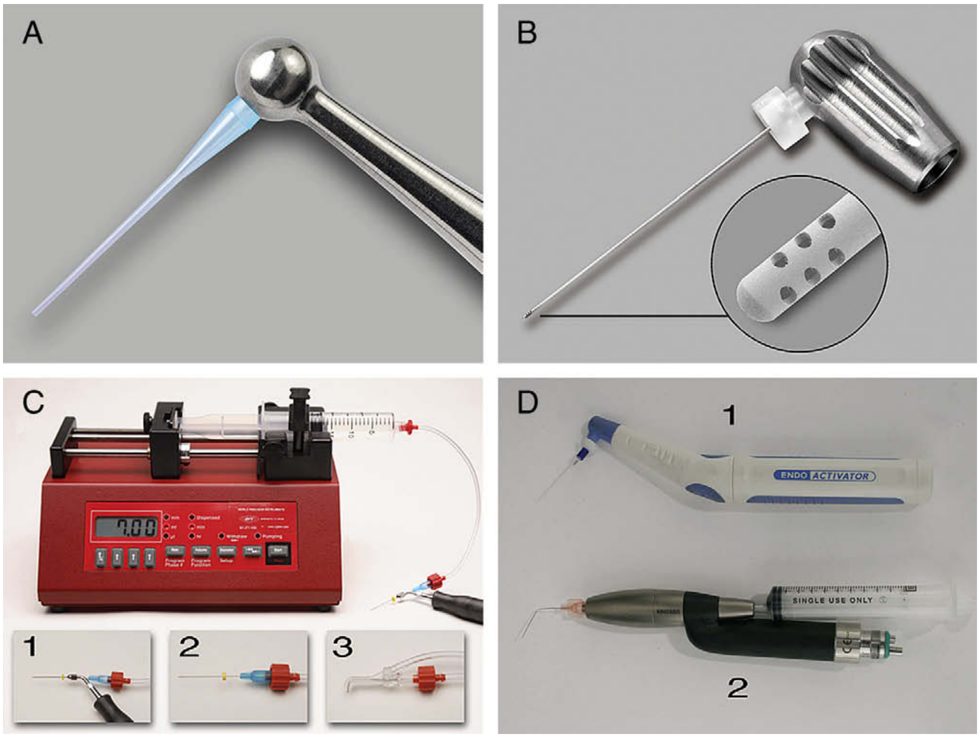

Figure 1. (*A*) The EndoVac plastic Macro and (*B*) stainless steel Micro cannulae are shown inserted in their respective titanium components. The Micro 's tip (enlargement) terminates with array of twelve 100-μm holes (only 6 are visible) extending between an area 0.2–0.7 mm from the spherical end of the cannula. (*C*) PSP at top was used to deliver irrigant through (*C-1*) the ultrasonic needle, (*C-2*) the Max-I-Probe, and (*C-3*) the EndoVac 's MDT. (*D1*) The battery-operated EndoActivator is shown with a plastic activation tip inserted. (*D2*) The Rinsendo is shown fully assembled; it delivers irrigant via internal pneumatic pressure.

handpiece is powered by dental air compressor and has irrigation speed of 6.2 mL/min. Research has shown promising results in cleaning the root canal system. Periapical extrusion of irrigant has also been reported (15).

Materials and Methods

Twenty-two single-rooted, extracted maxillary central and lateral incisors with mature apices were selected. The same 22 teeth were used in all 6 groups to avoid variables of different canal anatomy and apical diameter. A consistent and known volume of irrigant was delivered to each pulp canal, and all apical extrusion was trapped in a collection vial similar to that of Brown et al (8). The percent difference between the extruded and delivered irrigant was calculated and analyzed.

Canal Preparation

After conventional access preparation, canals were shaped by using a crown-down technique with Endo Sequence, rotary nickel titanium instruments (Brasseler USA Dental Instrumentation, Savannah, GA) to a master apical file (MAF) size of #50/04. MAF is defined as the largest file that binds slightly at correct working length after straight-line access. Once the teeth were shaped to MAF, a micro capillary tip (Ultradent Products Inc, South Jordan, UT) was used to deliver 6.0% sodium hypochlorite through the prepared root canal space, until no visual evidence of intracanal organic tissue was found.

Test Units and Irrigant Control

The test units were prepared in the following manner (Fig. 3). The prepared teeth were mounted through a hole in the mating lid (Fig. 3*A-1*) of a removable 20-mL collection vial (Research Product International Corp, Mt Prospect, IL) (Fig. 3*A-4*) next to an atmospheric equalization 18-gauge needle (Ultradent Products Inc) (Fig. 3*A-3*). Both the tooth and the 18-gauge needle were secured and sealed to the lid by using light-cure composite resins (Esthet-X, Dentsply Caulk; Dentsply International, Milford, DE) and yellow sticky wax (Kerr Lab, Sybron Dental, Orange, CA) (Fig. 3*A-2*). The collection vial was dried and weighed on a digital scale (Sauter; August Sauter of America, New York, NY) and then securely screwed into the tooth/needle/lid assembly (8).

In all tests, irrigation was accomplished with room temperature tap water delivered to the pulp canal according to manufacturer 's instruction. To maintain irrigation consistency, a programmable precision syringe pump (PSP) (Fig. 1*C*) (Alladin, AL 1000; World Precision Instruments, Inc, Sarasota, FL) was used to deliver between 3.48 and 3.53 mL at the precise rate of 7.0 mL/min, except for the Rinsendo, because it contains its own pneumatic pump and irrigation syringe. A custom-made Fluid Recovery Trap (FRT) (Fig. 3*A-5*) collected coronally expressed irrigant in group 3 (Fig. 3*C*) or the irrigant flow through the Micro and Macro cannulae in groups 1 and 2 (Fig. 3*A*).

Testing Procedure

Group 1: Micro Cannula, EndoVac. The MDT was attached to the PSP to deliver irrigant into the pulp chamber (Fig. 3*A-6*). The micro cannula was attached to FRT (Fig. 3*A-8*), placed at full working length, and used according to manufacturer 's instructions.

Group 2: Macro Cannula, EndoVac. The Macro cannula was used as described in group 1. Its apical advancement ended wherever the intracanal diameter prevented its further apical extension.

Group 3: EndoActivator. The PSP was attached to irrigation needle that delivered irrigant into the pulp chamber (Fig. 3*C*). The