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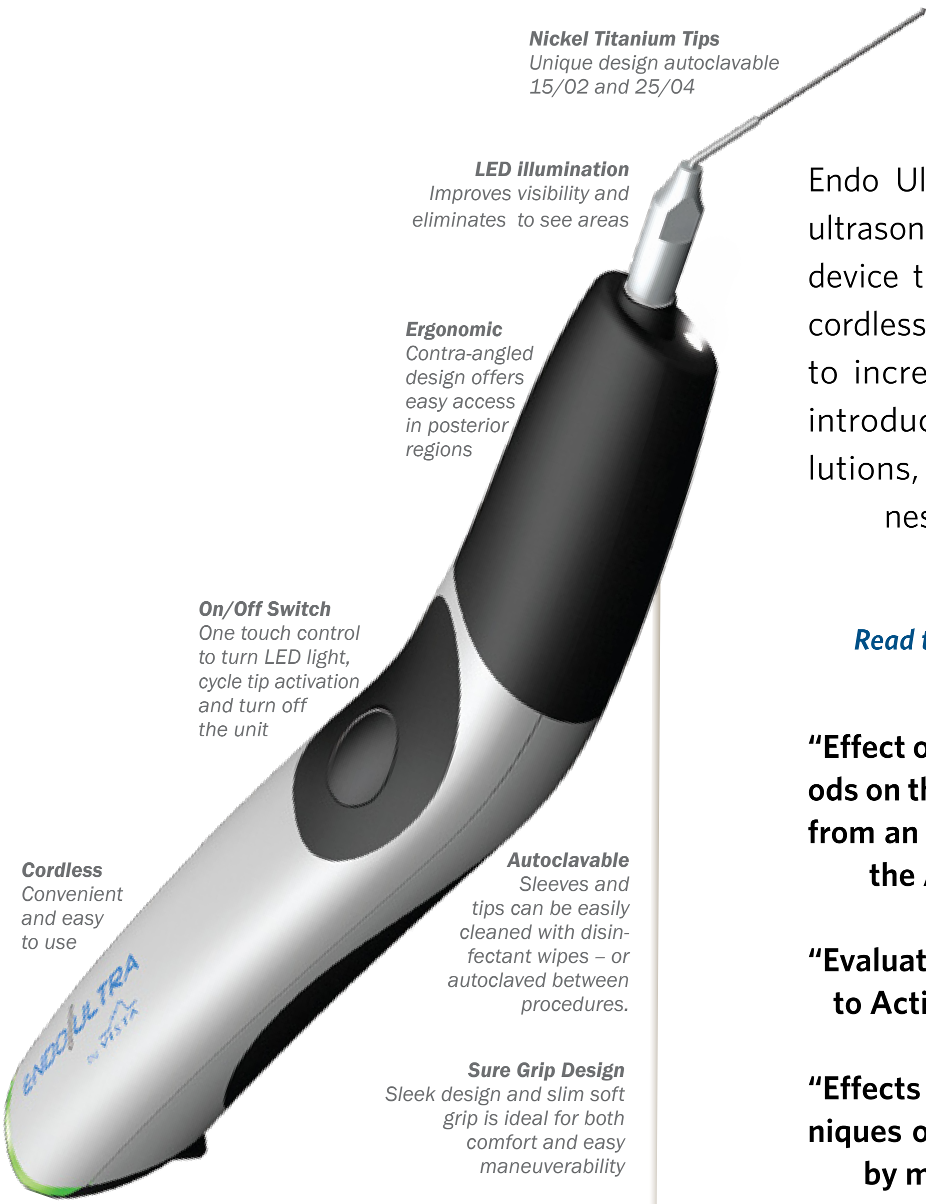

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"3D Fill Report"

Effect of Different Final Irrigation Methods on the Removal of Calcium Hydroxide from an Artificial Standardized Groove in the Apical Third of Root Canals

Ismail Davut Capar, DDS, PhD, Erhan Ozcan, DDS, PhD,† Hakan Arslan, DDS, PhD,* Huseyin Ertas, DDS, PhD,* and Hale Ari Aydinbelge, DDS, PhD†*

Abstract

Introduction: The aim of this study was to compare the efficacy of conventional syringe, ultrasonic, EndoVac (Discus Dental, Culver City, CA), and Self-Adjusting File (SAF) (Re-Dent-Nova, Ra'nana, Israel) irrigation systems in removing calcium hydroxide ($Ca[OH]_2$) from simulated root canal irregularities. **Methods:** The root canals of 88 extracted single-rooted teeth were prepared using ProTaper rotary instruments (Dentsply Maillefer, Ballagiues, Switzerland) up to size F4. The roots were split longitudinally, and a standardized groove was prepared in the apical part of 1 segment. The root halves were reassembled, and $Ca(OH)_2$ medicament was placed into the root canals using a Lentulo spiral. The roots were randomly divided into 4 experimental groups and 2 control groups according to the different irrigation systems used: conventional syringe irrigation, continuous passive ultrasonic irrigation (PUI), EndoVac irrigation, and SAF irrigation. Each group was then divided into 2 subgroups ($n = 10$) according to the irrigation protocol: subgroup 1: 10 mL 2.5% NaOCl and subgroup 2: 10 mL 17% EDTA + 10 mL 2.5% NaOCl. The amount of remaining medicament was evaluated under a stereomicroscope at 30× magnification using a 4-grade scoring system. The influences of the different $Ca(OH)_2$ medicament removal methods and irrigation protocols were statistically evaluated using 2-way analysis of variance and Tukey post hoc tests. **Results:** In the NaOCl-irrigated groups, PUI removed significantly more $Ca(OH)_2$ medicament than the other techniques ($P < .05$). There was no significant difference among the other groups ($P > .05$). In the EDTA/NaOCl-irrigated groups, the SAF and PUI removed significantly more $Ca(OH)_2$ than the other techniques ($P < .05$). **Conclusions:** The use of the SAF system with the combination of EDTA and NaOCl enhanced $Ca(OH)_2$ removal when compared with the use of only NaOCl irrigation with the SAF. Continuous PUI and SAF were more effective than EndoVac, and conventional syringe irrigation in the removal of the $Ca(OH)_2$ medicament from an artificial standardized groove in the apical part of the root canal. *(J Endod 2014;40:451–454)*

Key Words

Calcium hydroxide, EndoVac, Self-Adjusting File, ultrasonic irrigation

Calcium hydroxide, $Ca(OH)_2$ is used in endodontic treatment as an intracanal medication and has good antimicrobial properties against the majority of endodontically relevant pathogens (1). Research has shown that remnant $Ca(OH)_2$ on dentin walls can affect the penetration of sealers into the dentinal tubules and increase apical leakage (2). Therefore, complete removal of $Ca(OH)_2$ placed inside the root canal before obturation of the root canal system is recommended. The most frequently described method for removing $Ca(OH)_2$ is instrumentation of the root canal with a master apical file at the working length and copious irrigation of sodium hypochlorite (NaOCl) and EDTA (3).

Previous studies have investigated the efficacy of $Ca(OH)_2$ removal with different devices and irrigation systems (4–9). Continuous passive ultrasonic irrigation (PUI) uses an ultrasonically activated file inside the root canal with a continuous irrigant supply from the handpiece. Studies showed that PUI was more effective in removing $Ca(OH)_2$ from the root canal walls than delivery of the irrigant by positive pressure (5–7).

The EndoVac system (Discus Dental, Culver City, CA) is an apical negative pressure (ANP) irrigation device designed to deliver irrigating solutions to the apical portion of the canal system and to suction out debris (10). The ANP of the EndoVac system effectively cleans dentinal surfaces. ANP irrigation at a sufficient volume and flow removes the smear layers and displaces debris (11).

The Self-Adjusting File (SAF) system (Re-Dent-Nova, Ra'nana, Israel) adapts itself to the 3-dimensional shape of the root canal to allow for continuous irrigation during the preparation and the activation of the irrigants through vibration (12). The SAF system is operated by vibrating a slightly abrasive lattice in an in-and-out motion to remove dentin (13). The SAF is more effective in removing dentine debris from the root canal than rotary instrumentation (14). However, whether the SAF can remove $Ca(OH)_2$ medicament from the root canal wall is not known. The aim of this study was to compare the efficacy of the EndoVAC, PUI, and SAF systems in the removal of $Ca(OH)_2$ from mechanically unreachable regions in the apical part of straight root canals.

Materials and Methods

Ethical approval for this study was obtained from the Ethics Committee of Izmir Katip Celebi University (number of the document: 157/2013).The experimental design

From the *Department of Endodontics, İzmir Katip Çelebi University, İzmir, Turkey; and †Department of Endodontics, Selçuk University, Konya, Turkey.

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Address requests for reprints to Dr Ismail Davut Capar, Department of Endodontics, Faculty of Dentistry, Katip Çelebi University, Izmir 35620, Turkey. E-mail address: capardt@hotmail.com

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Evaluation of a Sonic Device Designed to Activate Irrigant in the Root Canal

Lei-Meng Jiang, DMD, Bram Verhaagen, MSc,† Michel Versluis, PhD,† and Lucas W. M. van der Sluis, DDS, PhD**

Abstract

Introduction: The aims of this study were to evaluate the removal of dentin debris from the root canal by sonic or ultrasonic activation of the irrigant and the physical mechanisms of sonic activation by visualizing the oscillations of the sonic tip, both inside and outside the confinement of the root canal. **Methods:** Roots of 18 canines were embedded, split, and prepared into standardized root canals. A standard groove was cut on the wall of one half of each root canal and filled with the same amount of dentin debris before irrigation procedures. The removal of dentin debris was evaluated after different irrigation procedures. The oscillations of the sonic tip were visualized *ex vivo* by using high-speed imaging at a time scale relevant to the irrigation process, and the oscillation amplitude of the tip was determined under 20× magnification. **Results:** After irrigation, there was a statistically significant difference between the experimental groups ($P < .0001$). Without irrigant activation, the grooves were still full of dentin debris. From the ultrasonic activated group, 89% of the canals were completely free of dentin debris, whereas from the sonic group, 5.5%–6.7% were ($P = .0001$). There was no significant difference between the sonic activation groups. **Conclusions:** Activation of the irrigant resulted in significantly more dentin debris removal; ultrasonic activation was significantly more efficient than sonic activation. The oscillation amplitude of the sonically driven tips is 1.2 ± 0.1 mm, resulting in much wall contact and no cavitation of the irrigant. *(J Endod 2009;■:1–4)*

Key Words

Activation, irrigation, root canal, sonic, ultrasonic

From the *Department of Endodontology, Academic Centre of Dentistry Amsterdam (ACTA), University of Amsterdam and VU University, Amsterdam; and †Physics of Fluids group, Faculty of Science and Technology, University of Twente, and Research Institute for Biomedical Technology BMTI, University of Twente, Enschede, The Netherlands.

Address requests for reprints to Dr Lei-Meng Jiang, CEP, Louwesweg 1, 1066EA Aamsterdam, noordholland, The Netherlands. E-mail address: l.jiang@acta.nl.

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Irrigation of the root canal space is a fundamental aspect of root canal treatment. Techniques for acoustic and hydrodynamic activation of the irrigant have been developed (1–3), because syringe irrigation is not effective in the apical part of the root canal (4, 5).

It has been shown that acoustic streaming and cavitation contribute to the cleaning efficiency of root canal irrigation (2, 3, 6). Acoustic streaming can be defined as a rapid movement of fluid in a circular or vortex-like motion around a vibrating file (7). Cavitation can be defined as the creation of vapor bubbles or the expansion, contraction, and/or distortion of preexisting bubbles (so-called cavitation nuclei) in a liquid; the process is coupled to acoustic energy (8). Studies have shown that passive sonic activation of irrigant is inferior to its counterpart in ultrasonic (9, 10). However, the details concerning those mechanisms have not been clarified.

The EndoActivator system (Advanced Endodontics, Santa Barbara, CA), a sonic device, has recently been developed for root canal irrigation. Special polymer tips can be driven sonically at 3 different frequencies to activate the irrigant. No data are currently available to support its use.

The aims of this study were (1) to determine the removal of dentin debris from the root canal by sonic or ultrasonic activation of the irrigant and (2) to evaluate the physical mechanisms of sonic activation by visualizing the oscillation amplitude of EndoActivator tips.

Materials and Methods

High-speed Imaging Experiments

An optical set-up was constructed to visualize the effect of sonic activation in a glass model of the root canal containing water. The canal was 10 mm in length, with an apical diameter of 0.30 mm and a taper of approximately 0.06. Imaging was performed by using a high-speed camera (Shimadzu Corp, Kyoto, Japan) at a frame rate of 4000 frames per second. From these recordings the oscillation amplitude of the tip was measured by using a calibrated reference grid (Edmund Optics, Barrington, NJ)

A microscope with 1.25–20× magnification was used (BX-FM; Olympus, Tokyo, Japan) for magnification. The root canal was illuminated in bright-field by a continuous wave light source (ILP-1; Olympus).

Dentin Debris Removal Model

Straight roots from 18 extracted human maxillary canines were decoronated to obtain uniform root sections of 15 mm. The roots were embedded in self-curing resin (GC Ostron 100; GC Europe, Leuven, Belgium) and then bisected longitudinally through the canal in mesiodistal direction with a saw microtome (Leica Microsystems SP1600, Wetzlar, Germany). The surfaces of both halves were ground successively with 240-, P400-, and 600-grit sandpaper, resulting in smooth surfaces on which only little of the original root canal lumen was left. Four holes were drilled in the resin part, and the 2 halves could be reassembled by 4 self-tapping bolts through the holes (Fig. 1*A*).

New root canals were prepared by K-files #15/.02 (Dentsply Maillefer, Ballaigues, Switzerland) and HERO 642 (MicroMega, Besançon, France) nickel-titanium rotary instruments to a working length (WL) of 15 mm, ISO size 30, and taper 0.06, resulting in standardized root canals. During preparation, the canals were rinsed with 1 mL of 2% NaOCl after each file and delivered by a 10-mL syringe (Terumo, Leuven, Belgium) and a 30-gauge needle (Navitip; Ultradent, South Jordan, UT).

Effects of four Ni–Ti preparation techniques on root canal geometry assessed by micro computed tomography

O. A. Peters[1], K. Schönenberger[1] & A. Laib[2]

Departments of [1]Preventive Dentistry, Cariology and Periodontology; and [2]Biomedical Engineering, ETH, University of Zurich, Zurich, Switzerland

Abstract

Peters OA, Schönenberger K, Laib A. Effects of four Ni–Ti preparation techniques on root canal geometry assessed by micro computed tomography. *International Endodontic Journal*, **34**, 221–230, 2001.

Aim The aim of this study was to compare the effects of four preparation techniques on canal volume and surface area using three-dimensionally reconstructed root canals in extracted human maxillary molars. In addition, μCT data was used to describe morphometric parameters related to the four preparation techniques.

Methodology A micro computed tomography scanner was used to analyse root canals in extracted maxillary molars. Specimens were scanned before and after canals were prepared using Ni–Ti – K-Files, Lightspeed instruments, ProFile .04 and GT rotary instruments. Differences in dentine volume removed, canal straightening, the proportion of unchanged area and canal transportation were calculated using specially developed software.

Results Instrumentation of canals increased volume and surface area. Prepared canals were significantly more rounded, had greater diameters and were straighter than unprepared canals. However, all instrumentation techniques left 35% or more of the canals' surface area unchanged. Whilst there were significant differences between the three canal types investigated, very few differences were found with respect to instrument types.

Conclusions Within the limitations of the μCT system, there were few differences between the four canal instrumentation techniques used. By contrast, a strong impact of variations of canal anatomy was demonstrated. Further studies with 3D-techniques are required to fully understand the biomechanical aspects of root canal preparation.

Keywords: canal geometry, micro-CT, Ni–Ti, quantitative analysis.

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Introduction

Canal preparation is one of the major steps in root canal treatment and directly related to subsequent disinfection and obturation. In recent years, the advent of Ni–Ti rotary root canal preparation techniques like ProFile (Dentsply Maillefer, Ballaigues, Switzerland) or Lightspeed (Lightspeed Inc, San Antonio TX, USA), has altered the perception of canal instrumentation. Consequently, the performance of these rotary techniques requires close evaluation.

Several publications discussed aspects of root canal preparations using plastic blocks (Thompson & Dummer 1997, Bryant *et al.* 1998a, 1998b). Whilst having the advantage of standardized dimensions, plastic blocks lack the material qualities of human dentine. Furthermore, canal curvature as simulated in plastic blocks is only two-dimensional. Another *in vitro* approach used cross-sections of human root canals to determine the amount of dentine removed and cross-sectional canal transportation (Bramante *et al.* 1987, Portenier *et al.* 1998). Recently, microcomputed tomography (μCT) has evolved as a promising tool in endodontic research (Bjørndal *et al.* 1999, Rhodes *et al.* 1999).

Correspondence: Dr Ove Peters, Department of Preventive Dentistry, Cariology and Periodontology, Division of Endodontology, University of Zurich, Plattenstr. 11, CH-8028 Zurich, Switzerland (fax: + 41 1634 4308; e-mail: peters@zzmk.unizh.ch).

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3D fill REPORT

VOL. 1 NO. 2

Removing the Barriers to 3-Dimensional Fills

Achieving a successful, three-dimensional root canal filling starts long before you begin your obturation protocol. Filling the many intricacies of any root canal system first requires that it's highly complex anatomy is enlarged, shaped, cleaned, disinfected and ready to receive your obturation material.

What barriers are standing in the way of your next 3D fill? And what can you do to successfully remove them? The challenge starts, very literally, when your rotary or hand file comes in contact with the dentinal wall.

Rotary Instrumentation: Excellence, Efficiency and One Small Problem

The steps of root canal therapy are interdependent, each building toward successfully healing periradicular periodontitis – and preventing its recurrence. The role of instrumentation is to remove the root canal content – particularly the vital and non-vital tissue contributing to the infection within the root canal system – while retaining as much of the tooth's dentinal structure as possible. Certainly, advancements with nickel-titanium rotary instruments have dramatically improved the efficiency and predictability of the shaping process. However, the application of rotary instruments, as effective as they are, results in a tangible, new problem: **smear layer**. It's an unattractive name for the byproduct conglomerate consisting of necrotic pulp tissue, dentinal shards, collagen tissue and bacteria that is created as you "enlarge and shape" the canal.

FIG. 1 Variances in canal morphology dictate that even the best instruments only touch part of the canal space. Untouched canal anatomy spaces, depicted here in green, may harbor bacteria that can lead to root canal therapy failure. Image courtesy of Dr. Ove Peters.