

Comparison of the Vibringe System with Syringe and Passive Ultrasonic Irrigation in Removing Debris from Simulated Root Canal Irregularities

Tina Rödig, Dr. med. dent,* Meral Bozkurt,* Frank Konietschke, Dr,[†] and Michael Hülsmann, Prof. Dr. med. dent*

Abstract

Introduction: The aim of this study was to compare the efficiency of a sonic device (Vibringe), syringe irrigation, and passive ultrasonic irrigation in the removal of debris from simulated root canal irregularities. **Methods:** Root canals with 2 standardized grooves in the apical and coronal parts were filled with dentin debris. Three different irrigation procedures were performed with NaOCl (1%) and (1) syringe irrigation, (2) Vibringe, and (3) passive ultrasonic irrigation. The amount of remaining debris was evaluated by using a 4-grade scoring system. **Results:** Ultrasonic irrigation removed debris significantly better from the artificial canal irregularities than the Vibringe System and syringe irrigation ($P < .0001$). The Vibringe System demonstrated significantly better results than syringe irrigation in the apical part of the root canal ($P = .011$). **Conclusions:** Passive ultrasonic irrigation is more effective than the Vibringe System or syringe irrigation in removing debris. The sonic device demonstrated significantly better results than syringe irrigation in the apical root canal third. (*J Endod* 2010;36:1410–1413)

Key Words

Debris, irrigation, root canal, sonic, ultrasonic, Vibringe System

From the *Department of Preventive Dentistry, Periodontology and Cariology, and [†]Centre for Statistics, University of Göttingen, Göttingen, Germany.

Address requests for reprints to Dr T. Rödig, Department of Preventive Dentistry, Periodontology and Cariology, University of Göttingen, Robert-Koch-Str. 40, 37075 Göttingen, Germany. E-mail address: troedig@med.uni-goettingen.de. 0099-2399/\$0 - see front matter

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Disinfection of the root canal system by using antimicrobial and tissue-dissolving irrigants is considered an essential part of chemomechanical debridement (1). Residual pulp tissue, bacteria, and dentin debris remain in areas that are routinely left uninstrumented after root canal preparation (2, 3). Reports on the efficacy of irrigation at different coronal-apical levels have been contradictory (4, 5). Therefore, a coronal groove was added to an existing research model (6) to evaluate debris removal not only from apical but also from coronal thirds of the root canal. Conventional syringe irrigation is still widely accepted (3), although its flushing action is not sufficient in removing debris from root canal irregularities (2, 7). Enhancement of the flushing action of irrigants by ultrasound is well-documented (8, 9) and has the potential to remove dentin debris and organic tissue from inaccessible root canal areas (10, 11). Conflicting results regarding the effectiveness of sonic or ultrasonic activation of the irrigant to remove smear layer, debris, and bacteria (12–14) have been published. Recently, the Vibringe System (Vibringe B. V. Corp, Amsterdam, Netherlands), an irrigation device that combines manual delivery and sonic activation of the solution, has been introduced. The Vibringe is a cordless handpiece that fits in a special disposable 10-mL Luer-Lock syringe that is compatible with every irrigation needle. No data on the effectiveness of this system are available at present.

The aim of the present study was to compare the efficiency of conventional syringe irrigation, the Vibringe System, and passive ultrasonic irrigation (PUI) in the removal of dentin debris.

Material and Methods

Specimen Preparation

Ten extracted maxillary lateral incisors with straight roots were decoronated to obtain a standardized root length of 17 mm. The root canals were prepared with Flex-Master (VDW, Munich, Germany) nickel-titanium rotary instruments to a working length (WL) of 16 mm and an apical size of #35/02. Between the instruments, irrigation was performed with 2 mL NaOCl (1%) by using a syringe and a 30-gauge needle (Navitip; Ultradent, South Jordan, UT). The roots were split longitudinally into 2 halves, allowing subsequent reassembling. A modified finger spreader was inserted into an ultrasonic handpiece (Piezon Master 400; EMS, Nyon, Switzerland) to cut 1 longitudinal groove of 4.0-mm length, 0.2-mm width, and 0.5-mm depth into root canal dentin of each half. The locations of the grooves were 2–6 mm from WL in one root half (apical section) and 10–14 mm from WL in the opposite half (coronal section). This experimental design is based on a previous study (6) and has been used in several investigations concerning the removal of debris (15–17). Subsequently, digital photographs of the root halves were taken before and after irrigation from identical angles by using a microscope (MOTIC Ergonomic Trinokular Zoom Stereo Mikroskop; Motic, Wetzlar, Germany) with 30× magnification. Dentin debris was produced by mixing 100 mg dentin chips with 0.175 mL NaOCl (1%) in a standardized ratio to achieve a wet sand-like consistency. Each groove was filled with debris to simulate a clinical situation when dentin debris accumulates in uninstrumented root canal extensions. Subsequently, the root halves were reassembled and fixed by using a clamp.

Irrigation Procedures

Preliminary experiments had shown that a single specimen could be reused up to at least 5 times without visible damage to the root canal surface. Therefore, the 10 teeth were used repeatedly in the 3 experimental groups. The irrigation procedures were performed consecutively with a random sequence of the specimens. In group 1, irrigation was accomplished with a 10-mL syringe and a 30-gauge needle (NaviTip). In group 2, the irrigant was delivered and sonically activated via the Vibringe System by using a 30-gauge needle (NaviTip) according to manufacturer's instructions. In group 3, irrigation was performed with an ultrasonic device (Piezon Master 400) and a stainless steel K-type file size 15 (Endosonore; Maillefer, Ballaigues, Switzerland), with its power set at the $\frac{1}{4}$ of the scale. In all groups a total volume of 20 mL NaOCl (1%) was delivered. The flow rate in groups 1 and 2 was approximately 5 mL/min. In group 3, the delivery rate during PUI with a continuous flush of the irrigant was 10 mL/min. Insertion depth of the needle and the ultrasonic file was 1 mm short of WL in all groups. After irrigation the root halves were separated to take digital photographs of the canal walls. The remaining debris was removed from the grooves, followed by a complete refilling of the root canal extensions before the next irrigation procedure. All measures were carried out under a microscope at $30\times$ magnification.

Scoring Procedure and Statistical Analysis

The amount of remaining debris in the grooves was scored under the microscope with $30\times$ magnification by 2 calibrated dentists with a scoring system described previously (18): 0, the groove is empty; 1, less than half of the groove is filled with debris; 2, more than half of the groove is filled with debris; 3, the complete groove is filled with debris (Fig. 1). Intraobserver reproducibility and interobserver agreement were calculated. In cases of differences, both scores were included in the statistical analysis that was performed with a nonpara-

metric analysis of variance for factorial longitudinal data and the closed testing principle ($P = .05$).

Results

Interobserver agreement was 90% ($\kappa = 0.9057$, confidence interval = 0.8310–0.9804), and intraobserver reproducibility was 98% ($\kappa = 0.9843$, confidence interval = 0.9626–1), with no significant influence of the observer ($P = .9825$). The results of the scoring procedure are presented in Fig. 2 and Table 1. There were statistically significant differences between the experimental groups ($P < .0001$) and the location of the groove ($P < .0001$). A significant interaction between the irrigation protocol and the location of the groove ($P = .018$) was found. For syringe irrigation and Vibringe System, pairwise comparisons demonstrated significantly better cleanliness of the apical groove ($P = .005$; $P = .002$, respectively). No difference between the grooves was detected for ultrasonics ($P = .160$), which removed debris significantly better than Vibringe System and syringe irrigation ($P < .0001$), irrespective of the location of the groove. For the coronal groove, the difference between syringe irrigation and the use of the Vibringe System was not statistically significant ($P = 1$). In contrast, the results for the apical groove demonstrated a significantly better performance for Vibringe System than for syringe irrigation ($P = .011$). Overall, the cleanliness of the apical groove was significantly superior in comparison to the coronal groove ($P < .0001$). None of the specimens irrigated with a syringe showed completely clean artificial root canal irregularities without any remaining debris (score 0). Debris was completely removed after irrigation with the Vibringe System in 5% of the specimens and after PUI in 92.5% of the specimens.

Discussion

The design of the present study is comparable to that described by Lee et al (19) and has been used in several other investigations

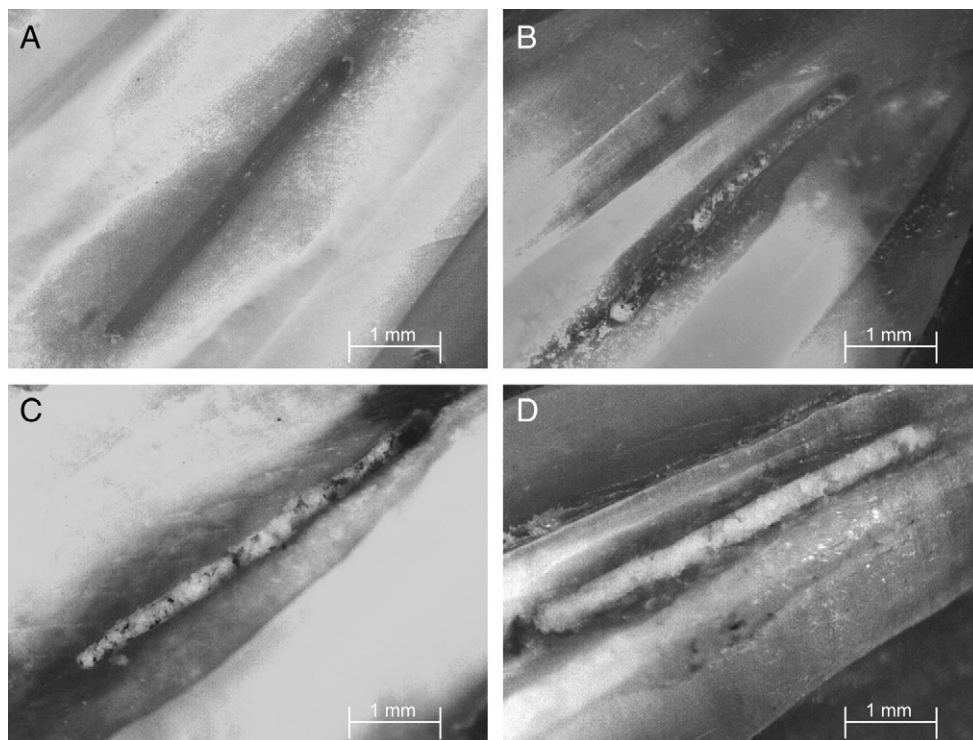


Figure 1. Standardized debris score for grooves according to van der Sluis et al (18). (A) Score 0: the groove is empty; (B) score 1: less than half of the groove is filled with debris; (C) score 2: more than half of the groove is filled with debris; (D) score 3: the complete groove is filled with debris. Original magnification, $\times 30$.

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