

## Efficacy of a new activation device in irrigant penetration into simulated lateral canals

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### ABSTRACT

**Objective:** The aim of the present study was to compare the effects of EasyClean (EC) on irrigant delivery into simulated lateral canals using an artificial closed canal system. Passive ultrasonic irrigation (PUI) was used as a reference technique for comparison.

**Materials and Methods:** Forty simulated curved root canals manufactured in transparent resin and with simulated lateral canals were instrumented with Reciproc R40 files and randomly assigned to four groups (n = 10) according to the irrigant activation technique: PUI group, ECrec group (EC used in reciprocating motion), ECrot group (EC used in rotary motion), and control group (no activation performed). After activation, stereomicroscope images from each block were taken, and irrigant penetration into lateral canals was measured using Adobe Photoshop software. Data were analysed using ANOVA and Tukey's post hoc test ( $\alpha = 0.05$ ).

**Results:** No penetration was observed in the control group. The ECrec group showed lower penetration than the other group ( $P < 0.05$ ). No differences were observed between the ECrot group and the PUI group ( $P > 0.05$ ).

**Conclusion:** EC used in rotary motion was effective in increasing the penetration of the irrigating solution into simulated lateral canals.

**Keywords:** EasyClean; root canal irrigation; passive ultrasonic irrigation

### INTRODUCTION

One of the aims of endodontic therapy is to remove vital and necrotic pulp tissue and micro-organisms and their toxins from root canals (1). However, the complexity of root canal anatomy makes this difficult (2,3). Isthmuses, lateral canals, anastomoses and other irregularities within the root canal often harbour tissue, microorganisms and debris (4,5). These areas require adequate irrigation to complete the cleaning and disinfecting processes (6).

It has been shown that the efficacy of irrigating solutions could be increased by using irrigant activation techniques (7). Passive ultrasonic irrigation (PUI) transmits acoustic energy from an instrument to the irrigation solution, creating acoustic microstreaming and cavitation (8,9). Microstreaming enhances the mechanical cleansing of canal walls by moving the solution against the root canal surfaces, debriding areas not reached with mechanical instrumentation. Recently, EasyClean, a novel irrigant activation device, was developed (Easy Equipamentos Odontológicos, Belo Horizonte, Brazil) (Figure 1). EasyClean is an acrylonitrile butadiene styrene plastic device designed to produce vigorous intracanal fluid agitation. The instrument has a size of 25/.04 and an aircraft wing-shaped cross section. According to the manufacturer, EasyClean increases the efficacy of irrigation and has two additional advantages, increased safety and versatility, because it can be mounted on an engine available at a practitioner's office (10).

The aim of the present study was to compare the effects of EasyClean on irrigant delivery into simulated lateral canals using an artificial closed canal system. PUI was used as a reference technique for comparison. The null hypothesis tested was that there were no differences between the two techniques regarding delivery into simulated lateral canals.

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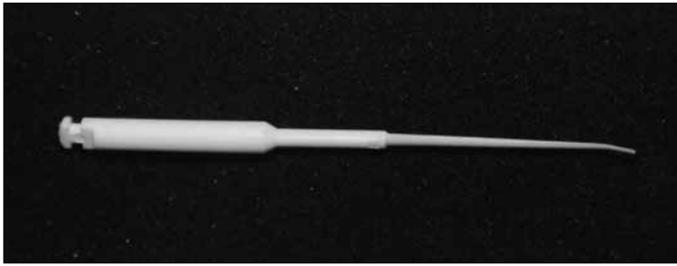


Figure 1. EasyClean device.

## MATERIALS AND METHODS

Forty simulated curved canals in transparent resin blocks with three lateral canals with 0.15 mm (IM do Brasil, São Paulo, Brazil) were randomly assigned to four groups (n=10), according to the irrigant activation protocol: PUI group, ECreC group (EasyClean used in reciprocating motion), ECrot group (EasyClean used in rotary motion), and control group (no activation performed). To resemble a clinical situation, a closed system was created by coating each canal with soft modelling wax (Technew, Rio de Janeiro, Brazil). This coating sealed the apical foramen and all lateral canals. All procedures were performed at room temperature (20°C).

In all groups, stainless steel size 10 K-file instruments (Dentsply Maillefer, Ballaigues, Switzerland) were used to explore the canals up to the working length (WL), creating a standardised glide path. Then, the canals were prepared with R40 instruments (40/.06) at the pre-setting program (Reciproc ALL) powered by a torque-controlled motor (VDW Silver; VDW, Munich, Germany). The instrument was then gradually advanced in the root canal until it reached two-thirds of the WL and was then moved in a slow and gentle in-and-out pecking motion that was approximately 3 mm in amplitude. After each of the three complete in-and-out pecking movements, the instrument was removed from the simulated canal and cleaned in a sponge.

Apical patency was confirmed between each preparation step using a size 10 K-file beyond the WL, and the canals were irrigated with a contrast 2% methylene blue solution. Irrigation was performed using a 30-G NaviTip needle (Ultradent Products, South Jordan, USA) placed at a depth just short of the binding. A total of 10 mL of irrigant was used during instrumentation.

In the control group, irrigation was performed without the activation of the solution, and in the experimental groups, the following procedures were adopted.

### PUI group

Initially, a total volume of 2 mL of contrast solution was delivered and left in the canals using the 30-G NaviTip needle. Ultrasonic activation was performed using a stainless steel ultrasonic tip (Irrisonic E1; Helse, Santa Rosa de Viterbo, Brazil) mounted on an ultrasonic unit (PM 200, EMS, Geneva, Switzerland). The tip was passively inserted 3 mm from the WL and

activated in 20 s using a power setting of 20%, as recommended by the manufacturer. This procedure was repeated three times. The total irrigant volume in each canal was 6 mL, and the total activation time was 1 min (11).

### ECreC group

Initially, a total volume of 2 mL of contrast solution was delivered and left in the canals using the 30-G NaviTip needle. The EasyClean file was mounted on a VDW Silver motor, and the tip was passively inserted 3 mm from the WL and activated using the Reciproc ALL program. This procedure was repeated three times. The total irrigant volume for each canal was 6 mL, and the total activation time was 1 min.

### ECrot group

Initially, a total volume of 2 mL of contrast solution was delivered and left in the canals using the 30-G NaviTip needle. The EasyClean file was mounted on a VDW Silver motor, and the tip was passively inserted 3 mm from the WL and activated in rotary motion at 1000 rpm. This procedure was repeated three times. The total irrigant volume for each canal was 6 mL, and the total activation time was 1 min.

After the activation procedures, a round silicone base with a rectangular slot fitting the microscope base was positioned under a stereomicroscope (S8 APO, Leica, Wetzlar, Germany) connected to a digital camera (CMOS 10 megapixels, Opticam, São Paulo, SP, Brazil). The rectangular slot matched the exact dimensions of the resin blocks. The digital image of each specimen was captured using Leica Application Suite 3.6 (Leica) at 1.25× magnification and was saved in TIFF.

Then, one trained evaluator, blinded to the group assignment of each sample, analysed the images using Adobe Photoshop CS6 Extended software (Adobe Systems Inc., San Jose, CA, USA). The extension of the irrigant penetration was measured in mm for each lateral canal. Data were analysed using BioEstat (MCT-CNPq, Belém, PA, Brazil), version 5.0. The difference between the groups was compared using one-way analysis of variance followed by Tukey's post hoc test ( $P < 0.05$ ).

## RESULTS

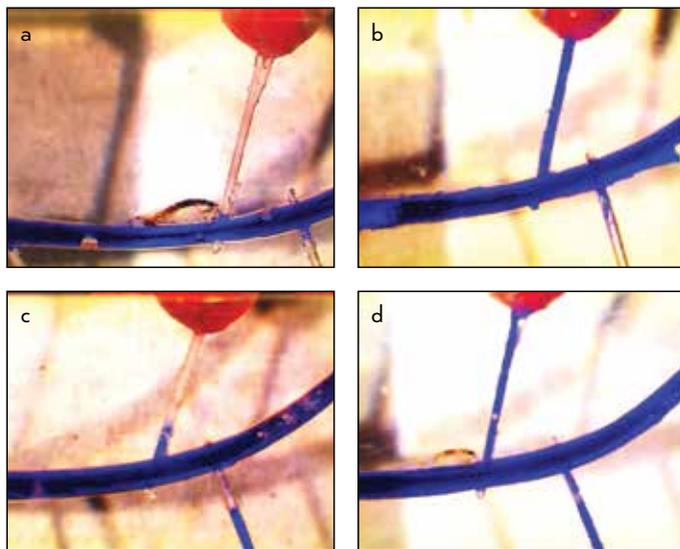
The mean values of irrigant penetration into lateral canals are presented in Table 1. The control group did not demonstrate any penetration. Among the experimental groups, EasyClean used in reciprocating motion showed significantly lower penetration than the other tested groups ( $P < 0.05$ ). No differences were observed between the EasyClean used in rotary motion and PUI groups ( $P > 0.05$ ). Figure 2 shows the representative samples of all tested groups. Visual inspection showed that EasyClean used in both reciprocating and rotary motion caused no detectable canal transportation or ledges. However, PUI caused transportation or ledges in nine samples (Figure 3).

**TABLE 1.** Mean and standard deviation (SD), in mm, of irrigant penetration for the different experimental groups.

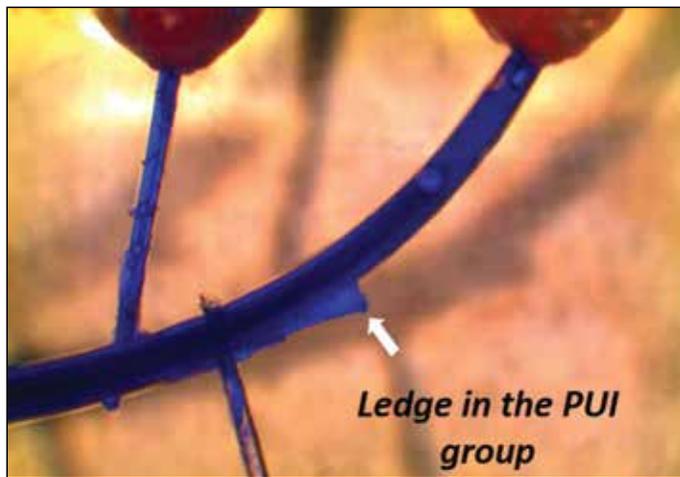
Irrigant Activation Protocol	Mean (+SD)
ECrec	3.53 ( $\pm$ 2.25) <sup>a</sup>
ECrot	5.47 ( $\pm$ 1.76) <sup>b</sup>
PUI	5.83 ( $\pm$ 1.11) <sup>b</sup>

<sup>(a)</sup> Different letters indicate a significant difference between the means involved (Tukey's test).

ECrec-EasyClean used in reciprocating motion; ECrot-EasyClean used in rotary motion; PUI-passive ultrasonic irrigation.



**Figure 2.** a-d. Representative samples of all tested groups. (A) Control group, (B) PUI group, (C) ECrec group and (D) ECrot group.



**Figure 3.** Image representing irrigant penetration in the PUI group. The white arrow indicates ledge formation.

## DISCUSSION

Ramifications present in the root canal, such as lateral canals, have great clinical importance in endodontic outcomes, particularly when associated with lateral lesions (12). Persistent intraradicular infections caused by bacteria located within dentinal tubules can be responsible for the reappearance of apical periodontitis (13). This highlights the importance of achieving proper disinfection of the root canal for obtaining

a predictable long-term treatment outcome. Bacteria causing persistent infections are usually located in areas unaffected by instruments and antimicrobial substances, including lateral canals, apical ramifications and isthmuses (1). In this study, to reproduce conditions observed in clinical practice, 0.15-mm simulated lateral canals were used, which matches the size of lateral canals reported in previous studies (14,15).

The results of the present study revealed that EasyClean used in rotary motion and PUI outperformed EasyClean used in reciprocating motion. Therefore, the null hypothesis was rejected. Previous studies have shown that PUI improves the irrigation of the lateral canals, debridement, disinfection and smear layer removal (11,16). According to the manufacturer, EasyClean can be used either in rotary or reciprocating motion. Considering the motion kinematic, rotary motion (ECrot group) promoted a better irrigant penetration than reciprocating motion (ECrec group) ( $P < 0.05$ ). This result may be explained by the lower speed that EasyClean works inside the canal when used in reciprocating motion, which probably generates very low energy to cause sufficient streaming of the irrigant into narrow lateral canals. The results of this study seem to be in line with those of a recent study (17) that analysed debris removal, from recess areas, in the apical third of the root canals and found better results with EasyClean in comparison with PUI. Although the goals were different, both studies demonstrate the potential of the EasyClean device to increase irrigant penetration in difficult-to-reach areas. In the present study, a better result was observed with EasyClean used in rotary motion, while in the aforementioned study, EasyClean was used in reciprocating motion.

Despite the fact that no difference was observed between the PUI and ECrot groups, the former was associated with ledge formation in the resin canals. Previous studies had suggested that unintentional contact between the ultrasonic file and the root canal wall occurred due to the dimensions and complex geometry of the root canal, which could lead to the uncontrolled removal of dentine (18,19).

From an experimental point of view, two main *in vitro* models have currently been used to test irrigant penetration after irrigant activation protocols: simulated lateral canals using resin blocks or simulated lateral canals of extracted teeth (20,21). In the current study, resin blocks with simulated lateral canals were chosen as anatomy standardisation is a decisive factor in studies with this purpose. Using natural teeth, it would have been impossible to create standard-sized root canals, considering the variation in canal diameters at all different levels. Previous studies have shown the usefulness of simulated artificial root canals to study the efficacy of irrigation protocols (20-23). Nonetheless, there are evident limitations regarding the use of simulated canals in comparison with the real root canals, such as the porous nature of dentine, the presence of complicated morphology and the hydrophobic surface of the plastic. Thus, care must be taken before extrapolating the results of studies

using simulated canals to the clinical setting. A dye instead of sodium hypochlorite was used to check lateral canal penetration. Differences in surface tension and viscosity have to be accounted for in the results. However, the concentration of the methylene blue solution used was very low (only 2%) and it was produced by dilution in a sterile physiological saline solution. In a previous study, the wettability of a saline solution was shown to be very similar to a 2.5% NaOCl solution, without any statistical difference between them (for the saline solution: contact angle=17.50° and surface tension=186.87 mN/m; for 2.5% NaOCl: contact angle=21.25° and surface tension=177.39 mN/m) (24). Considering this, 2% methylene blue solution could be adequate to represent the wettability of a 2.5% NaOCl solution.

To be clinically relevant, *in vitro* studies should reproduce the clinical situation as much as possible (6). In *in vivo* conditions, the root is enclosed by the bone socket, and because of this, the canal behaves as a closed-end canal, which results in gas entrapment, producing a vapour lock effect during irrigant delivery (25). Studies that were designed to simulate such a closed system, to restrict fluid flow through the apical foramen, demonstrated incomplete debridement of the apical part of the canal walls with the use of a syringe delivery technique (26,27). To best reproduce the clinical situation, close-end and close-lateral canals were used in the present study.

Within the limitations of the current methodology, it can be concluded that the activation of the irrigant favours its penetration into the lateral canals, with better results obtained using EasyClean in continuous rotary motion and PUI.

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