International Journal of Dentistry and Oral Science (IJDOS)
ISSN: 2377-8075

# Apical Extrusion of Intracanal Bacteria Following Use of Three Different Rotary File Systems

Research Article

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## Abstract

**Aim**: To assess the Apical Extrusion of Intracanal Bacteria following use of Dentsply Trunatomy, Micromega Herogold and Micromega Hero Shaper Individual Classic file system.
**Materials and Methods:** Forty human single-rooted mandibular premolar teeth were randomly divided into four groups and contaminated with Enterococcus faecalis. The teeth in experimental groups were instrumented until reaching the working length with Trunatomy. Herogold and Heroshaper rotary file systems. Debris extruded from the apical foramen was collected into the test apparatus and the amount of bacteria was calculated. The data obtained were analyzed using Kruskal–Wallis one-way analysis of variance and Mann–Whitney U tests.
**Results:** Comparison of the mean number of colony forming units per ml of the extruded bacteria between Trunatomy, Herogold and Heroshaper shows no statistically significant difference between groups (P>0.05).
**Conclusion:** Within the limitations of this in-vitro study, it can be concluded that all instrumentation techniques produced measurable apical extrusion of debris. It is dependent on the practitioner to determine which system best suits their needs.

**Keywords:** Extruded Debris; Herogold; Heroshaper; Trunatomy.

## Introduction

Cleaning and shaping the root canal system is a significant goal of endodontic care. Dentinal chips, pulpal tissue fragments, necrotic tissues, microorganisms, and intracanal irrigants can all be extruded through the apical foramen during cleaning and shaping. Material extruded through the apical foramen has been related to post-instrumentation pain and a "flare-up" [1]. Bacteria and their products extruded into the periradicular tissues may cause an acute inflammatory response, the strength of which is dependent on the number and/or virulence of bacteria.

There is a balance between microbial aggression from the infecting canal microbiota and host defences in the periradicular tissues in asymptomatic chronic periradicular lesions associated with infected canals. If the bacteria are extruded apically during chemo-mechanical preparation, the host will be confronted with a greater number of irritants than initially. As a result, the balance between aggression and defence will be temporarily disrupted, causing the host to mobilise an acute inflammatory response to re-establish the equilibrium [1, 2].

The interappointment flare-up is a true complication marked by the onset of pain, swelling, or both after a few hours or days of root canal procedures and is severe enough to necessitate an unscheduled visit for emergency care [3]. Mild postoperative pain is very normal, even though the operation was performed according to appropriate guidelines, and patients should be prepared for it. An inter-appointment flare-up, on the other hand, has been shown to be a rare phenomenon. Mechanical, chemical, or microbial damage to the pulp-periradicular tissues are among the causes

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**Received:** May 19, 2021
**Accepted:** August 11, 2021
**Published:** August 18, 2021

**Citation:** Harish Selvaraj, Deepak Selvam, Muralidharan N.P. Apical Extrusion of Intracanal Bacteria Following Use of Three Different Rotary File Systems. *Int J Dentistry Oral Sci.* 2021;8(8):3936-3940. doi: http://dx.doi.org/10.19070/2377-8075-21000805

of interappointment flare-ups [2].

All preparation techniques and instruments have been reported to be associated with extrusion of infected debris, even when preparation is maintained short of the apical terminus [4]. Even when the preparation is done short of the apical foramen, all of the preparation instruments and techniques have been linked to the extrusion of contaminated debris [1]. The stepback technique created more debris than the engine-driven techniques and the balanced force technique [5]. The use of engine-driven nickel-titanium (NiTi) instrumentation in root canal procedures has grown in popularity over the last decade.

Newer instrument designs, such as non cutting tips, different cross sections, radial lands, and variable tapers, have recently been implemented to improve working safety, minimise working time, and increase flare in preparations [1]. Hence, this study aims to investigate the apical extrusion following the use of three different Nickel Titanium rotary file systems.

Previously our team had rich experience in working on various research projects across multiple disciplines [6-20]. Now the growing trend in this area motivated us to pursue this project.

## Materials and Methods

### Selection and Preparation of Teeth:

40 single-rooted human mandibular premolar teeth, freshly removed for orthodontic purpose from the outpatient clinic in the Department of Oral and Maxillofacial surgery at Saveetha Dental College were collected. The teeth with closed apices and curvatures less than 10° were selected. All the samples were tested using in the buccal and proximal directions, digital radiographs were taken to rule out the possibility of multiple canals. Teeth with apical openings and calcification was not included. After that, the teeth were brushed, soft tissue fragments and debris were removed and autoclaved twice for sterilization. The samples were stored in physiological saline solution at +4°C until it was required. An endodontic access cavity was prepared using size 1 Endo Access Bur (Dentsply Maillefer, Ballaigues, Switzerland) using a high-speed handpiece. Pulp chambers were accessed, and a reservoir was developed for the infection of root canals with Enterococcus faecalis suspension. The pulp remnants were then removed with a fine barbed broach, taking care not to pass the broach through the apical foramen. The working length was determined for all the samples using Ingle's method.

### Test Apparatus:

The entire setup was created using a plastic cuvette with a lid, of 1.5ml volume. By using a heated instrument a hole was created in the center of each cuvette lid. The tooth was then inserted from the top portion of the lid under pressure and fixed to the cementoenamel junction with epoxy resin and a hardener. The root's apical part was suspended inside the cuvette, which served as a collecting container for apical material evacuated through the root foramen. A 27-gauge needle was bent and forced alongside the lid of the cuvette to be used as a cannula for drainage and for balancing air pressure inside and outside the cuvette. The external surface of all roots was then coated with two coats of nail varnish.With the use of a size 15 K-file, a hole was made into the nail varnish that had covered the apical foramen before the experiment. 1 mm of instrument was extruded in this process. In this method a standard size of foramen and apical patency was achieved. The entire test apparatus was then sterilized using an autoclave for 20 minutes at 50lbs pressure.

### Contamination with Enterococcus *faecalis*:

To contaminate the root canal system, a pure culture of standard strain of E. faecalis was used. The pure culture of E. faecalis was inoculated in Brain-heart infusion agar and incubated overnight at 37 degree celsius aerobically. The suspension was made in 1 mL of sterile normal saline with turbidity matching 0.5 Mcfarland's standard. A sterile micropipette was used to contaminate the root canals with 10 µL [1.5 × 108 colony forming unit (CFU)] of the suspension in a laminar airflow cabinet to avoid any airborne contamination, and a size 10-K file was used to percolate the bacteria along the length of the root canals. The infected roots were then dried for 2 hours at 37°C in an incubator. The sterile 0.9% saline solution was then fully filled into the cuvette tubes. Till the process started the cuvettes were stored at 4 degree celsius.

### Methodology:

The prepared teeth samples were divided into four groups (n=10):
Group 1: Dentsply Trunatomy Files
Group 2: Micromega Herogold Files
Group 3: Micromega Heroshaper Files
Group 4: Uninstrumented group (Control)

### Root Canal Preparation:

The cuvette having the teeth samples were placed in a test tube to handle it conveniently during the root canal preparation process. All the root canal preparations were done with a low-speed endodontic handpiece (300 rpm) (Dentsply X Smart Plus). During the instrumentation process, the operator was shielded from seeing the root apex by a rubber dam that blocked the cuvette. For irrigation in between and at the end of instrumentation sequence, 2 mL of 2.5 percent NaOCl was used in each root canal. After that, 5 mL of 2.5 percent NaOCl solution was used for final irrigation. The irrigant was administered through a disposable plastic syringe with a 27-gauge needle attached, which was inserted into the canal until mild resistance was felt. All the rotary file systems were instrumented according to their respective sequence using their manufacturers instructions. The orifice modifier, glide path and shaping files were used in sequence for Dentsply Trunatomy and the orifice enlarger, shaping and finishing files in sequence for Micromega Herogold and Heroshaper using the crown down technique.

### Control Group:

After the teeth were contaminated and apical perforated, 10 teeth were chosen and maintained in the test medium. Subsequently, 0.1 mL NaCl was taken from the experimental vials for evaluating the bacteria, and then incubated in a brain–heart agar. Bacterial colonies were counted and the results were given as CFU.

**Statistical Analysis:**

The data obtained were analyzed using Kruskal–Wallis one-way analysis of variance and Mann–Whitney U tests. The level of statistical significance was kept at p = 0.05

## Results & Discussion

There was a difference in the mean number of extruded bacteria between Dentsply Trunatomy, Herogold and Heroshaper file systems but the results were not statistically significant. Trunatomy showed the least amount of extruded bacteria compared to Herogold and Heroshaper. The mean amount of bacterial extrusion is given in Table 1.

The aim of this study was to assess whether root canal shaping with three different nickel-titanium rotary file systems caused apical extrusion of intracanal bacteria. The amount and type of irrigant, as well as the operator, were common to all techniques. To reduce the number of variables and increase the likelihood that the amount of apically extruded bacteria was due to instrumentation, a standardised tooth model was used.

The teeth used in this study were carefully chosen based on tooth type, canal size at working length, and canal curvature. This ensured that the amount of apically extruded bacteria was not due to tooth morphology but rather due to the instrumentation. Dentsply Propex Pixi 2 was used to complete working length measurements in this study. The lip clip was attached to a needle during the procedure, and NaCl solution was used as a conducting medium. For all of the teeth, the working lengths were estimated to be 0.5 mm short of the apical foramen.

When contaminated or non contaminated intracanal materials are forced apically during root canal preparation, they may cause an inflammatory reaction, according to the well documented literatures. Persistent inflammation was related to even sterile dentine debris in the periapical region [21, 22]. A similar inflammatory condition can occur in a patient with chronic pulpitis or pulp necrosis, particularly if an apical periodontitis occurs, when root canal treatment is performed in contaminated canals [23]. New irritants in the form of chemically altered pulp tissue proteins may be introduced into the granulomatous lesion during cleaning and shaping, which may result in a violent reaction.

The presence of immunoglobulins in the periapical areas have also been demonstrated and some of the immunoglobulins were related to the antigens in the canals. If antigens are present in the canal and antibodies are present in the granuloma, an antigen–antibody complex will form as intracanal contents are forced through. This reaction damages the cell membrane, causing prostaglandin release, bone resorption, kinin system amplification, and eventually pain for the patient [23, 24]. Degranulation of mast cells in periapical tissues may be caused by physical or chemical damage to periradicular tissues during root canal preparation. Mast cells release vasoactive amines into the periapical tissues, triggering an inflammatory response or exacerbating an existing inflammatory process [25]. When bacteria that are immune to killing by host defense elements are transferred from the root canal into the periapical lesion, they have the ability to prolong the inflammatory response and delay healing. Therefore, every effort should be made to keep periapical extrusion of intracanal materials to a minimum during treatment.

Instrumentation technique, instrument type, instrument size,

**Table 1: Mean bacterial extrusion value between Trunatomy, Herogold and Heroshaper file systems P<0.05; SD, Standard Deviation.**

| Groups | Total (n) | Mean (CFU mL) | SD |
|---|---|---|---|
| **Trunatomy** | 10 | 6.1 | 1.19 |
| **Herogold** | 10 | 8 | 1.05 |
| **Heroshaper** | 10 | 7.8 | 1.03 |
| **Control** | 10 | 0.6 | 0.69 |

**Table 2: Kruskal-Wallis test shows no statistically significant difference of apical extrusion between Trunatomy, Herogold and Heroshaper file systems (P>0.05).**

| | Trunatomy | Herogold | Heroshaper |
|---|---|---|---|
| **Kruskal-Wallis H** | 2.740 | 1.494 | 1.918 |
| **dF** | 2 | 2 | 2 |
| **Asymp. Sig** | 0.254 | 0.383 | 0.474 |

**Table 3: Mann-Whitney U test shows no statistically significant difference of apical extrusion between Trunatomy, Herogold and Heroshaper file systems (P>0.05).**

| | Trunatomy | Herogold | Heroshaper |
|---|---|---|---|
| **Mann-Whitney U** | 0.000 | 0.500 | 1.000 |
| **Asymp. Sig. (2-tailed)** | 0.114 | 0.221 | 0.351 |

preparation endpoint, and irrigation solution are all factors that influence the amount of extruded intracanal materials [3], [26-33].

The Trunatomy files have a slim NiTi wire design with 0.8mm maximum flute diameter (MFD) with a heat treatment and off-centered cross section with regressive taper. It has a smaller flute diameter compared to the 1.2mm maximum flute diameter which has been used for most generic variable tapered files. The blend of file geometry, regressive tapers, and a slim, highly flexible wire allows for effective root canal treatment while only removing dentin where it's clinically necessary which might be the reason for comparably less extrusion of apical debris. The crown down technique was used in this study. The coronal third of the root canal contains the largest number of microorganisms. The root canal system's initial preparation helps to reduce the amount of microorganisms that could be pushed apically. Second, early flaring of the coronal portion of the preparation may help with instrument control during the apical third of the canal preparation [34].

The bacteriological marker used in this study was Enterococcus faecalis. It is a nonfastidious, easy-to-grow aerobic bacterium with important clinical implications that could be used in a bacteriological assessment method. Other bacteria typically associated with endodontic infections may require symbiotic support, but E. faecalis has been reported to survive and thrive on its own [35].

Our institution is passionate about high quality evidence based research and has excelled in various fields [10], [36-48].

## Conclusion

Overall, all the three nickel-titanium file systems extruded intracanal bacteria through the apical foramen. However, no significant difference was found in the number of CFU between Trunatomy, Herogold and Heroshaper file systems.

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