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Comparison of Three Different Rotary File Systems' Antibacterial Efficiency[1]

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Abstract

Aim: This study aims to compare the antibacterial activities of three different rotary file systems.

Material and Methods: In this in vitro study, 60 mandibular premolar teeth were randomly divided into three groups after the preliminary preparation for the study (n=20). After sterilization of the teeth in an autoclave, E. faecalis was cultivated in the root canals. Samples obtained before and after root canal shaping with rotary file systems were planted in the blood agar medium. E. faecalis colonies formed after the incubation process were counted (cfu=colony forming unit).

Results: Mann-Whitney U test with Bonferroni Correction results were found as SAF B< Pro-B ve SAF B<Rec B cfu ($p<0.001$). No significance was found between Pro B and Rec B cfu numbers ($p = 0.978$).

Conclusion: It has been concluded that the SAF system is more effective in terms of chemomechanical activity than the other two rotary file systems when compared by considering the antibacterial activity of the SAF, ProTaper, and Reciproc Rotary file systems.

Key Words: Antibacterial effect, SAF, ProTaper, Reciproc.

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Introduction

The success of root canal treatment depends on the chemomechanical cleaning of the root canal to give it an appropriate shape, disinfection of the root canal, and sealing the canal (1). Disinfection of the root canal system with the use of antimicrobial and tissue dissolving washing solution is considered the basis of chemomechanical preparation (2).

The reduced oxygen tension, limited nutrient availability, and the presence of antimicrobials in the root canal environment after chemomechanical processes lead to a decrease in the number and species of microorganisms in the root canal system (3).

Ni-Ti rotary files are more flexible than stainless steel instruments and have the ability to return to their original shape after bending. It is generally accepted that the shaping and widening of curved root canals is much more difficult with stainless steel files than with Niti rotary files. In addition, Ni-Ti rotary files have sufficient intracanal cleaning and shaping efficiency, especially in curved canals, thanks to their superelastic advantages (4,5). These files are used with the crown-down shaping technique, which allows access to the apical one-third while minimizing the loss of radicular dentin. The crown-down technique reduces root canal transportation and lodging and facilitates the removal of coronal debris (6).

ProTaper Universal (PTU; Dentsply Tulsa Dental, Tulsa, OK) is a well-described NiTi rotary system of instruments manufactured with a varying taper over the file length, convex triangular cross-sections, and noncutting tips. These features allow all instruments to move safely through the canal, while the noncutting tip enhances the ability to find its way through soft tissue and debris (7).

The Self-Adjusting File (SAF) is a hollow file designed as a thin-walled, pointed cylinder composed of a thin nickel-titanium lattice. The SAF system provides three-dimensional adaptation in the canal as it adapts to the cross-section of the canal, unlike all other rotary file systems that only show longitudinal adaptation in the canal when the files are placed in the canal (8).

The Reciproc (VDW, Munich, Germany) file system is a reciprocating system that works completely against the current standard approach that requires entering the canal with prior hand filling before using a shaper file to minimize the incidence of breakage. In this new shaping view, it is claimed that there is no other prerequisite for access to the canal. The shaper file follows the weakest resistance in the natural path present in the canal (9).

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The goal of the present in vitro study was to investigate the ability of the three different rotary file systems to eliminate viable Enterococcus faecalis populations from root canals of mandibular premolar teeth.

Materials and Methods

In the study, 60 teeth (single-rooted and single-canalled permanent mandibular premolar human teeth) extracted for various reasons in the Oral and Maxillofacial Surgery Department of the Faculty of Dentistry of Dicle University were used. After the teeth were prepared for study, the conventional canal access cavities were opened in a round shape on the occlusal surface of the tooth using diamond burs. After shaping the root canals with a #20 hand file, the smear layer was removed with NaOCl and EDTA irrigation. For inactivation of residual NaOCl, the canals of each tooth were washed with 2 ml of 10% sodium thiosulfate and dried with absorbent paper points.

In order to ensure standardization, the 60 teeth to be used in the study were divided into 3 groups of 20. Mueller-Hinton Broth (*Fluka*, *Biochemika* Sigma Aldrich Chimie, St Quentin Fallavier, France), prepared under sterile conditions, was poured into six sterilized glass bottles of 200 ml and 10 teeth were added to each bottle and the mouths of the glass bottles were sealed. Glass bottles containing 10 teeth and 200 ml medium were sterilized in an autoclave at 121 °C for 20 minutes.

E. faecalis strain ATCC 29212 was used to bacterial standardization. To inoculate the tooth roots, 2 ml of the liquid suspension of E. faecalis was added to each glass bottle. After the glass bottles were closed and the bottles were gently shaken to mix the suspension into the culture medium, the samples were left to stand in an oven set at 37 °C for 1 week to allow bacterial formation and contamination of the teeth.

The teeth inoculated with E.faecalis were sealed with fast-curing epoxy resin to create a closed channel termination and prevent from bacterial leakage. Dental crown containing pulp chamber and root surface were disinfected with 2 ml of 2.5% NaOCl, then 2 ml of 10% sodium thiosulfate was applied for NaOCl inactivation.

Root canals were washed with 1 ml of sterile saline solution to remove unadhered cells in the canal, and four sterile paper cones were inserted into the canal with four sterile paper cones until they reached the working length, and each paper cone was kept in the canal for 1 min. Paper cones absorbing the channel contents were transferred to sterile glass tubes containing 1 ml medium suspension, and these samples were coded with 'A' next to the group names.

ProTaper Group

The canal preparation was performed with ProTaper rotary files, starting from SX and using the F2 file, accompanied by irrigation of 2.5% NaOCl and 17% EDTA until the canal preparation was completed at the working length.

RECIPROC Group

Canal preparation was carried out gradually, using a special reciprocation program with a Reciproc R40 canal file, accompanied by irrigation of 2.5% NaOCl and & 17% EDTA with a single file, until the working length was reached.

SAF Group

Root canal preparation was performed with the SAF system consisting of a combination of vibration head, Vatea device and RDT3 file, accompanied by irrigation of 2.5% NaOCl and 17% EDTA, until the working length was reached.

A total of 20 ml of NaOCl and 5 ml of EDTA were used for channel irrigation for each channel in all three study groups.

Sampling Procedure After Shaping

In order to inactivate the residual NAOCL in the canal of the teeth that have completed chemomechanical shaping processes, the canals were washed with sodium thiosulfate solution, and four sterile paper cones were placed in the canal, and each paper cone was kept in the canal for 1 min. The paper cones removed from the canal were transferred to sterile glass tubes containing 1 ml of medium suspension and the samples were coded with the letter 'B' next to the group names. The samples taken before and after the preparation process were vortexed and inoculated into a blood agar medium. The number of colonies in ml of bacteria grown in media incubated at 37 °C for 24 hours was determined as cfu/ml.

The percentages of the differences between the SAF, ProTaper, and Reciprocal groups were compared with the Kolmogorov-Smirnov (KS) Test. The Nonparametric Post-Hoc Test was analyzed with the Bonferroni Corrected Mann-Whitney U Test to find out which group caused the difference from the groups found to be different with the Kolmogorov-Smirnov Test.

Results

It was found after microbiological examinations of the initial samples taken that intensive bacterial colonization occurred after bacterial cultivation in the canals of all sixty premolar teeth that made up all experimental groups. Intensive bacterial growth was observed in the

initial (Group A) and post-processing (Group B) samples taken from one tooth from the SAF group, one tooth in the ProTaper group, and two teeth in the Reciproc group, and it was determined that there was no decrease in the intensity of bacterial growth.

Table 1: Kolmogorov-Smirnov Test results of percentage values of SAF, ProTaper and Reciproc Groups initial and post-procedure differences.

	Mean	Std. Deviation	Median	Minimum	Maximum	KS test (χ^2)	P
SAF	0,0512	0,223	0,0001	0,000005	1,000		
Pro	0,0613	0,222	0,010	0,0001	1,000	15.79	<0.001
Rec	0,107	0,306	0,002	0,0005	1,000		

In all three study groups, the cfu values in the group (Group B) obtained from the samples after chemomechanical shaping were found to be statistically significantly lower than the cfu values in the group (Group A) obtained from the samples before chemomechanical shaping ($p<0.001$) (Table 1).

The cfu values in the group (SAF Group B) obtained from the samples after chemomechanical shaping with the SAF system were found to be statistically significantly lower than the cfu values in the groups (Pro B Group and Rec Group B) obtained from the samples after chemomechanical shaping with the Protaper and Reciproc system ($p<0.001$) (Table 1).

There was no statistically significant difference between the cfu values in the group obtained from the samples after chemomechanical shaping with the ProTaper rotary file system (Pro Group B) and the cfu values in the group obtained from the samples after chemomechanical shaping with the Reciproc system (Rec Group B) ($p=0.978$). (Table 2)

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Table 2: Mann-Whitney U Test results with Bonferroni Correction

Groups Compared	Mann-Whitney U	p	Bonferroni Correction P
SAF-Pro	0,0512	0,223	0,0001
SAF-Rec	0,0613	0,222	0,010
Pro-Rec	0,107	0,306	0,002

Discussion

Chemomechanical shaping is one of the most important factors in the disinfection of infected root canals from bacteria. Studies have shown that Enterococcus feacalis is a resistant microorganism that plays a major role in the etiology of permanent periradicular lesions after root canal treatment (10-13). Therefore, Enterococcus feacalis (ATCC 29212) strains were used in our study to evaluate the efficacy of the chemomechanical preparation.

In previous studies, researchers have often concluded that sodium hypochlorite has broad-spectrum antimicrobial activity (14,15). Although sodium hypochlorite has a wide range of use as an irrigation solution in endodontics, there is no consensus regarding the ideal use concentration (16,17). Some studies (18,19) showed that 5.25% sodium hypochlorite is necessary for the elimination of bacterial chains in infected root canals, but Hu et al. (20) examined the effects of contact time and concentration of sodium hypochlorite on dentin deproteination and reported that 0.5% sodium hypochlorite concentration should be used in routine root canal treatment to minimize the risk of dentin deproteination. In the current study, 20 ml of 2.5% sodium hypochlorite solution and 5 ml of 17% EDTA solution were used as irrigating agents for each tooth in all groups for the standardization of the groups.

In-group analysis showed that all three rotary file systems produced significant reductions in intracanal bacterial count. This result is consistent with several previous reports on the antibacterial efficacy of chemomechanical procedures (21-23).

Although bacterial reduction was achieved to a large extent in the study groups, negative cultures could not be obtained in all three groups. As mentioned in the micro-CT studies already conducted, no rotary file system can contact completely all of the root canals (24-26). Moreover, it has been stated in previous studies that regardless of the canal shaping and irrigation method, areas unaffected by the chemomechanical preparation may remain due to anatomical variations in the root canals (27-30). In the current study, although we achieved a high rate of bacterial elimination in all three shaping groups, the teeth could not be completely

decontaminated from bacteria due to these reasons. In addition to the physical limitations of the canal files, the inadequacy of sodium hypochlorite in the canal during endodontic treatment may also be considered the reason.

The SAF system works completely apart from the conventional irrigating method with syringes and needles. The file in the form of a hollow flexible cage is used with continuous irrigating provided by a special device called Vatea. The irrigation solution enters the file through the silicone tubing, and the solution is constantly renewed during the process, ensuring that it is fresh and effective in the canal (31). In addition to the three-dimensional adaptation of the file to the canal walls in the SAF system, the continuous renewal and activation of the irrigating solution by the Vatea system may also have contributed to the superior bacterial elimination compared to other rotary file procedures.

Conclusion

The SAF system, which has a different working design, ensures the elimination of more bacteria in the root canals compared to the ProTaper and Reciproc rotary file systems since it works with continuous irrigating and performs the filing process by sanding the dentin walls. However, it is thought that more comparative studies should be done.

Conflict of interest

The authors have no conflict of interest in this paper.

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