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Original Article

A Short Report on the Effectiveness of Edge Taper Platinum and XP-3D Shaper for the Reduction of *Enterococcus faecalis* Count in the Root Canal System: An *Ex Vivo* Study

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Abstract

Background: Intracanal microorganisms are the main cause of radicular lesions and, therefore, should be removed from the root canal system. *Enterococcus faecalis* is a resistant bacterium isolated from 30%–90% of endodontically-treated teeth, commonly chosen for *in vitro* studies on endodontic treatment methods. Different methods have been suggested for removing this bacterium from the root canal system, while none have been approved as the gold standard method. This study aimed to compare the effectiveness of Edge Taper Platinum and XP-endo® shaper rotary files in reducing the number of *E. faecalis* in the root canal system.

Methods: In this *ex vivo* study, 58 single-rooted single-canal teeth were immersed in formalin for 1 hour, stored in 0.9% saline, and randomly divided into positive control (n=4), negative control (n=4), platinum (n=25), and shaper (n=25). *E. faecalis* was injected into the root canals of all groups, except for the negative control group. The teeth were then incubated in a CO_2 incubator for 24 hours. Primary samples were collected, and the root canals were instrumented using the XP-endo® shaper and Edge Taper Platinum. Secondary samples were collected and cultured, and the number of colonies was counted after 24 hours of incubation. The data were analyzed using the Kruskal-Wallis and Mann-Whitney tests at a $P<0.05$.

Results: A significant difference was observed for the reduction of the *E. faecalis* colony count in 87.79%, 97.83%, and 14.11% of the XP-endo® shaper (87.79%), Edge Taper Platinum (97.83%), and positive control (14.11%) groups ($P<0.05$).

Conclusion: Both XP-endo® shaper and Edge Taper Platinum files with equal apical sizes effectively reduced the number of *E. faecalis* colonies in the root canal system. Edge Taper Platinum with a greater taper was more effective.

Keywords: Carbon dioxide, *Enterococcus faecalis*, Platinum

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Background

Bacteria and their byproducts cause pulpal and periapical diseases, and, thus, they should be eliminated from the root canal system during root canal treatment (1). Among the various microorganisms causing endodontic infections (2), *Enterococcus faecalis*, isolated from 30%–90% of endodontically-treated teeth (3,4), is resistant to antimicrobial irrigating solutions and calcium hydroxide. In addition, it survives in the root canal system (without the synergistic effect of other bacteria), making it a popular choice for *in vitro* studies on endodontic treatment methods (5).

Cleaning and shaping the root canal are among the most challenging phases of the endodontic treatment with hand files (6). Nickel-titanium (NiTi) rotary files with high super-elasticity and resistance to cyclic fatigue (7) significantly reduced the incidence of clinical procedural errors (8,9) and became popular choices among dental

clinicians. Improved instrument design and new alloys have been proposed to overcome the drawbacks of NiTi instruments, such as fracture possibility (10). The rotary system Edge Taper Platinum has shown superior flexibility and fatigue resistance thanks to its advanced thermal treatment process (11), compatible with a variety of rotary motors and low-speed handpieces (12).

XP-endo® Shaper is a snake-shaped file, introduced in 2015, activated at different temperatures with six cutting blades at the tip, adaptable to the root canal morphology and expandable/contractible along with the working length (reaching an apical diameter of 30; 4% taper) (13), making it superior to conventional systems in performance (13,14) and intracanal bacterial reduction (15,16). Despite numerous studies comparing the effectiveness of different rotary files in reducing or eliminating microorganisms in the root canal system (17–19), few studies have compared the efficacy of XP-endo® Shaper on bacterial elimination with other systems (20,21). As no previous study has compared the efficacy of Edge Taper Platinum and XP-endo® shaper in eliminating *E. faecalis*, this study sought to compare the effectiveness of these two in reducing *E. faecalis* count in the root canal system.

Materials and Methods

The Ethics Committee of Semnan University of Medical Sciences (IR SEMUMS.REC.1397.161) approved all the protocols of the current study. In this *ex vivo* study, 58 human single-canal teeth with (a minimum of 15 mm) straight roots and round canals without endodontic treatment were selected, comprising maxillary anterior teeth and mandibular premolars. Teeth with root caries, fractures, more than one canal, root recession or calcification, and oval-shaped or curved canals were excluded from the investigation. The sample size was calculated at 21 in each experimental group and four in each control group, considering the effect size of 0.8, a power of 80%, and a confidence interval of 95% by the equation of sample size calculation considered for comparing the mean values in two independent samples using G*Power software. A total of 58 single-canal teeth entered the study and were randomly divided into two experimental groups (25 in each group) and two control groups (four teeth in each group; negative and positive control [only rinsed with saline]).

The crowns were cut to yield 15 ± 1 mm of root length (22,23). Coronal flaring was performed using #2 and #3 Gates-Glidden drills to standardize the canals. All canals were then instrumented with #20 hand-files to 1 mm shorter than the apical foramen (24,25).

The root canals were thoroughly cleansed using a combination of 17% ethylenediaminetetraacetic acid (Meta Biomed, South Korea) and 2.5% sodium hypochlorite (Darougar, Iran) for 3 minutes. The canals were then rinsed using sterile distilled water to ensure complete removal of any remaining debris (23,26). Cyanoacrylate glue (Razi Company, Iran) was used to seal the apical foramen, followed by two layers of nail varnish on the root surface of all teeth. The teeth were then mounted in microtubes containing acrylic resin (Acropars Company, Iran) and sterilized in an autoclave (Reyhan Teb Company, Iran).

To induce infection in the root canals, *E. faecalis* suspension (ATCC 29212) with a 0.5 McFarland standard concentration was inoculated into the canals. The teeth were then incubated at 37 °C for 24 hours. Primary samples were collected from inside the canals using three #15 paper points (Ariadent Company, Iran), with each paper point remaining in the root canal for 1 minute. The three paper points were then transferred into microtubes containing 1 mL of sterile brain-heart infusion broth.

The suspension was cultured on agar plates (Pronadisa Company, Madrid, Spain), and the colonies were counted after the plates were incubated at 37°C for 24 hours. After sample collection, the root canals were instrumented with the XP-endo® shaper and Edge Taper Platinum rotary files, according to the manufacturer's instructions.

Group 1 underwent root canal instrumentation using the XP-endo® shaper (FKG Company-Swiss). With a recommended speed of 800 rpm and torque of 1 N/cm, the file was used to reach the working length, and filing was performed for 1 minute to widen the canal to the diameter of a #30 file with a 4% taper (27).

Group 2 underwent root canal instrumentation using the Edge Taper Platinum (Edge Endo Company, Albuquerque, NM), which has three files for shaping and three files for finishing, operating at 350 rpm and 3.5 N/cm torque. The sequence of the used files was S1 (17, 0.2%), S2 (17, 0.4%), F1 (20, 0.6%), F2 (25, 0.6%), and F3 (30, 0.6%) for the working length. During instrumentation, the root canals were rinsed with 5 mL of saline.

The tip size was similar in both groups. The number of apical preparations was up to 30, but the taper was 4% in the XP-endo® taper and 6% in the edge shaper. In the XP-endo® shaper single-file system, the canals were rinsed after each time the file was removed, and in the Edge Taper Platinum system, the canals were rinsed when the files were changed (28).

The conditions were completely the same; one rotary motor, the Marathon E class rotary motor, and a contra-angle 16:1 handpiece (Saeyang Company Korea) were utilized to regulate the speed and torque of the files during the root canal preparation process. Following the preparation, three #30 paper points were employed to collect samples from the root canals and then immersed into 1 mL of sterile brain heart infusion broth. After 24 hours of incubation, the colonies were counted by multiplying the number of colonies grown on the plate in the dilution (reported based on CFU/mL) to ensure the presence of *E. faecalis* (Figure 1). To confirm the presence of the bacteria, the cultured colonies on agar were cultured again on bile esculin agar (ibresco) (22). To maintain consistency, a single operator performed all procedures, and each rotary kit was autoclave-sterilized after each use

Figure 1. An Image of the Plate With Colonies Grown on Agar

and was not used more than five times.

The data were analyzed using SPSS software, version 22; the Shapiro-Wilk test showed that the distribution was not normal; thus, Mann-Whitney and Kruskal-Wallis tests were used, and $P < 0.05$ was considered significant.

Results

Twenty-five teeth were evaluated in each intervention group, and then the results were compared with those of the control groups. Table 1 presents the baseline mean and median values. The results revealed no difference in colony count before root canal instrumentation ($P = 0.80$), while after instrumentation, a significant difference was observed among the four groups ($P = 0.001$).

The mean reduction in *E. faecalis* colony count (Figure 2A) and percentage (Figure 2B) showed a significant difference among the groups, with a significant difference between each of the interventions, namely, the XP-endo® shaper and Edge Taper Platinum groups, and the positive control. The percentage of mean reduction was 87.79%, 97.83%, and 14.11% for the XP-endo® shaper, Edge Taper Platinum, and the positive control groups, respectively ($P < 0.001$).

Discussion

The comparison of means, medians, and percentages of two rotary files, X Shaper and Edge Taper Platinum, demonstrated significant differences after both interventions compared with the positive control group; these results indicated both interventions as efficient methods for eliminating this microorganism from the root canal system. Most studies comparing the efficacy of these two rotary files emphasized instrumental and technical details, such as resistance to cyclic fatigue (9–11), which are not comparable with the results of the present study. While bacterial contamination is an important factor in the success of root canal treatment, radicular lesions primarily originate from intracanal bacteria, making the elimination of bacteria from the root canal system with the help of rotary systems imperative (25).

E. faecalis, an aerobic gram-positive coccus, is commonly used in studies because of its ability to easily proliferate in aerobic environments and is commonly isolated from the root canal system, especially in those with post-endodontic pain and infection (29). The great influence of *E. faecalis* on the root canal system might be related to the survival of *E. faecalis* solely without the presence of other bacterial species (4). Several studies have shown the effect of different rotary systems on the reduction of *E. faecalis* colony count and confirmed the effectiveness of various systems (23,26, 30). Considering the growing interest in single-file NiTi instruments for their cost-effectiveness and time-saving benefits, Edge Endo Company has developed Edge Taper Platinum, which has shown promising results for bacterial reduction in root canal teeth (31,32). These results are in line with those of the present study, which demonstrated a significant reduction of *E. faecalis* colony count by Edge Taper Platinum, indicating the efficacy of this rotary file on bacterial reduction, although not all of the root canals reached zero infection. Patel et al found that the K3XF file system was superior to Edge Taper Platinum, Protaper Gold, and Hyflex CM rotary systems (31). Vankayala et al also reported more bacterial extrusion by Hand K-files compared with Edge Taper Platinum, Protaper Gold, and Hyflex CM rotary systems with the K3XF file system (32). Each of these studies has indicated the efficiency of Edge Taper Platinum on bacterial reduction at different rates.

Another system, XP Endo® Shaper, was also considered in the present study as the second intervention. According to the manufacturer, this innovative tool has overcome the limitations of traditional files related to the three-dimensional shaping of the root canal system. The efficacy of this rotary system on bacterial reduction has also been proposed, attributed to its high flexibility, ability to expand the canal, and three-dimensional shaping of dentin in the XP-endo® shaper (15, 33, 34), which conforms to the results of the present study, highlighting its significant ability to reduce bacterial colony count in the root canal system. Alves et al evaluated the intracanal bacterial reduction (*E. faecalis*) and confirmed a more pronounced bacterial reduction by the XP-endo® shaper group compared with Reciproc (15). In an *ex vivo* study, Üreyen Kaya et al approved the bacterial reduction and disruption of the biofilm-like structure by instrumentation, while comparison showed the inferiority of the XP-endo® shaper in comparison with the Hyflex HDM single-file system in bacterial reduction (33). In an *in vivo* study by Elkalashy et al, the XP-endo® shaper decreased bacterial count but could not completely eradicate root canals from bacteria (34). These results corroborate our findings, although the second intervention group was different.

In the current study, it was attempted to evaluate the effectiveness of mechanical instrumentation in reducing bacterial count during root canal irrigation. To achieve this purpose, saline was used as the irrigating solution in the positive control group because it lacks antimicrobial properties and helps in a more accurate assessment of the

Table 1. The Comparison of the Mean and Median of the *Enterococcus faecalis* Colony Count (×10^5) Before and After Root Canal Instrumentation

	XP-endo® Shaper (n=25)	Edge Taper Platinum (n=25)	Positive control (n=4)	Negative control (n=4)	*P* Value*
Before					
Mean	5.94±1.68	6.23±1.38	6.05±0.71	0.00±0.00	0.80
Median	5.6 (2.60)	6.60 (2.93)	5.90 (1.35)	0 (0.00)	0.80
After					
Mean	0.66±0.20	0.13±0.18	5.2±0.66	0.00±0.00	<0.001
Median	0.7 (0.4)	0.09 (0.08)	5.05 (1.25)	0 (0.00)	<0.001

Note. *The result of Kruskal-Wallis tests.

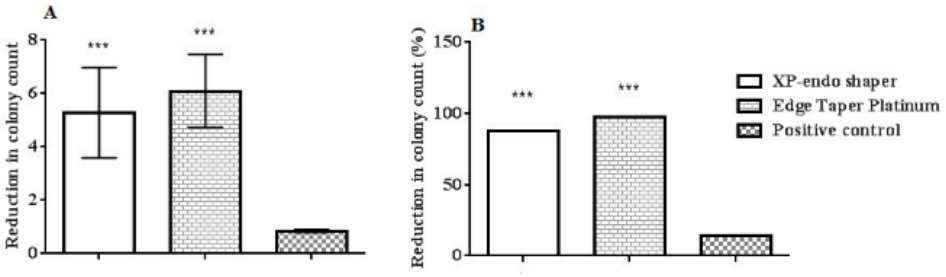

Figure 2. The Mean (A) and Percentage (B) of a Decrease in *E. faecalis* Colony Count (×10^5). *Note*. The superscript (***) shows significant differences between the intervention groups vs. the positive control

mechanical cleaning process (30). Others have employed a different solution, such as sodium hypochlorite (NaOCL), as the irrigating solution for evaluating the cleaning efficacy of ProTaper rotary files (22, 35). Similarly, Carvalho et al found that using the XP-endo® shaper in conjunction with sodium hypochlorite decreased colony count much more than sodium chloride (16). In the present study, all groups demonstrated a reduction in colony count, but the reduction was significantly greater following instrumentation with rotary files compared with saline alone. The higher frequency of root canal irrigation during instrumentation with the multi-file system might be attributed to factors affecting the cleaning efficacy of the XP-endo® shaper. It is worth noting that diagnostic microbiological techniques utilized for evaluating root canal infections, such as the culture method, microscopic assessment, immunological studies, and molecular biological assessments, may be different across studies. The culture method was used in the current study due to its broad-spectrum capabilities that allow the detection of unexpected strains and the ability to quantify microorganisms. Additionally, *E. faecalis* is easily cultured and makes an ideal choice.

The main strength of our research was comparing the efficacy of XP-endo® shaper and Edge Taper Platinum in reducing *E. faecalis* in the root canal system, which has not been addressed previously. However, our study had some limitations as well. The first limitation was related to the rotary files, which was a maximum of five times in the study. Furthermore, simultaneous sampling of canals after cleaning was impossible because of the time needed to autoclave the used files. An important notion to keep in mind is that we performed an *ex vivo* study; therefore, clinical interpretations should be made with caution.

Conclusion

Both the XP-endo® Shaper and Edge Taper Platinum rotary files with similar apical sizes are effective in reducing the number of *E. faecalis* bacteria in the root canal system. This study can provide clinicians with valuable insights into the selection of effective rotary files, which will ultimately increase the success of endodontic treatment.

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Authors' Contribution

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Competing Interests

The authors declare that they have no conflict of interests.

Ethical Approval

The Ethics Committee of Semnan University of Medical Sciences (IR SEMUMS.REC.1397.161) approved all the protocols of the current study.

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