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Comparison of Reciproc, Wave One, Protaper, and One Shape rotary instruments in reduction of bacterial load in root canals

KEYWORDS
Endodontics, Bacteria, Root canal therapy

PAROLE CHIAVE
Endodonzia, Batteri, Terapia canalare

Confronto della capacità di riduzione della carica batterica in canali radicolari degli strumenti Reciproc, Wave One, Protaper e One Shape

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Abstract

Aim: *To compare the effectiveness of Reciproc, Wave One, Protaper, and One Shape rotary instruments in reduction of E. faecalis in root canals.*
Methodology: *In this in-vitro study, after initial stages of canal enlargement and irrigation, a suspension containing Entrococcus faecalis was inoculated into the root canals of 84 extracted single-canal premolars. The samples (apart from two positive and two negative controls) were randomly assigned into four groups according to rotary instruments used: Reciproc, Wave One, One Shape, Protaper. Each group was then subdivided to two groups based on irrigating solutions of normal saline and NaOCl. After instrumentation, the root canals were filled with brain-heart infusion (BHI) broth. Finally bacterial colony forming units (CFU) were counted.*
Results: *Reduction in number of bacterial colonies before and after instrumentation and irrigation was not significantly different in different rotary instrument systems (P=0.128, F=1.955). However, NaOCl was more effective in reduction of bacterial load compared to normal saline (P<0.001, F=15.528).*
Conclusions: *All rotary instruments used in the study are effective in reduction of the bacterial load.*

Obiettivo: *confrontare la capacità di riduzione dell'E. Faecalis in canali radicolari degli strumenti Reciproc, Wave One, Protaper e One Shape.*
Materiali e Metodi: *in questo studio in vitro, dopo una fase iniziale di allargamento e irrigazione dei canali, 84 premolari estratti con singolo canale sono stati inoculati con una sospensione di Enterococcus Faecalis. I campioni (oltre a due controlli positivi e due controlli negativi) sono stati assegnati a quattro gruppi a seconda dello strumento utilizzato: Reciproc, Wave One, One Shape, Protaper. Ogni gruppo è stato a sua volta suddiviso in due gruppi a seconda che si utilizzasse come irrigante soluzione Salina o NaOCl. Dopo la strumentazione i canali radicolari sono stati riempiti di brain heart infusion (BHI). Successivamente sono state calcolate le unità formanti colonie (CFU).*
Risultati: *la riduzione nel numero di colonie batteriche prima e dopo strumentazione e irrigazione non è risultata statisticamente significativa fra i diversi sistemi di strumenti utilizzati (P=0.128, F=1.955). Comunque l'NaOCl è risultato più efficace nella riduzione della carica batterica confrontandolo con la soluzione salina (P<0.001, F=15.528).*
Conclusioni: *tutti gli strumenti utilizzati nello studio sono efficaci nella riduzione della carica batterica.*

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Introduction

It is known that bacteria and their byproducts are the main etiologic factors in pulpal and periapical disease (1). Bacterial biofilms have been found in most teeth with apical periodontitis (2). The primary goal in endodontic treatment is elimination of bacteria from the root canal system by mechanical and chemical means (3). Also persistent infection is the main reason of failures of endodontic treatment (4). *Enterococci* are facultative anaerobic bacteria. *Enterococcus faecalis* is the most common bacteria isolated from endodontically treated teeth (5). This microorganism can penetrate the dentinal tubules and resist mechanical and chemical debridement and intracanal medicaments thus causing reinfection of the root canals (6).
Various techniques are suggested for debridement of root canal system. Mechanical instrumentation removes the infected dentin from root canal walls. Irrigants solve the organic debris in the canal and remove the microorganisms. However, regardless of technique and material complete disinfection of root canal system is not possible (7, 8). In modern endodontics, engine-driven instrumentation by rotary Nickel-Titanium (NiTi) files has been recruited increasingly for preparation of root canals as it reduces procedural error, preparation time, and operator fatigue compared to manual instrumentation (9, 10). Reciproc (RC, VDW, Munich, Germany) and Wave One (WO, Dentsply Maillefer, Ballaigues, Switzerland) files are made of a special NiTi alloy called M-wire created by an innovative thermal treatment process (11). This alloy provides increased flexibility of the instruments and improved resistance to cyclic fatigue (12). Moreover, the reciprocating motion in these two systems which necessitates the use of special motors, leads to less stress accumulation in the file and makes the instrument less susceptible to separation (13). Universal Protaper (PT, Dentsply Maillefer, Ballaigues, Switzerland) rotary system has a modified cross-sectional design similar to that of K-file. This design allows the instrument to cut the dentin more electively and thus reduces torsional loads (14). One Shape (OS, Micro-Mega, Besancon, France) is another rotary instrumentation system with a non-working safety tip that ensures effective apical progression avoiding obstructions which can lead to instrument separation (15).
Based on our knowledge, no previous study has compared the effectiveness of the aforementioned rotary systems in reduction of bacterial load from root canals. Therefore, the aim of the present study was to compare the effectiveness of RC, WO, PT, and OS rotary instruments in reduction of *E. faecalis* in root canals.

Materials and Methods

84 extracted single canal premolars with complete apices which were extracted for orthodontic reasons were selected. Radiography was used to confirm that only one root canal exists. The crown of the teeth is cut to achieve a root length of 15 mm. The point of termination of root canal preparation was the apical foramen. After debridement, the root canals were filled with EDTA 17% solution for 1 min and then irrigated by sodium hypochlorite (NaOCl) 1% and sterile water to remove the smear layer. Then the apical end of the teeth was sealed with composite resin and the outer surface of the roots was covered with epoxy resin in order to prevent from bacterial leakage. The teeth were then individually mounted on gypsum blocks for better handling during instrumentation. Thereafter, they were packed and sterilized in an autoclave (121 ˚C, 30 min, 15 psi). Two of the teeth were not sterilized as negative controls. Bacterium used in this study was *Entrococcus faecalis* (ATCC29212). The bacterium was cultured on brain-heart infusion (BHI) medium reaching the 1.5x108 colonies and a bacterial suspension was prepared. Eppendorf tubes containing sterile teeth were placed under laminar flow hood and inoculated by the bacterial suspension using a sterile pipet. Fresh BHI medium was added to the sam-

Table 1

Logarithm of number of bacterial colonies before and after instrumentation and irrigation

		Before		After	
File	**Irrigant**	**Mean**	**SD**	**Mean**	**SD**
Reciproc	NaOCl	1320	469.61	158	50.29
	Saline	1624	391.90	546	192.54
Wave One	NaOCl	1338	409.82	164	69.15
	Saline	1366	478.80	679	229.45
Protaper	NaOCl	1375	589.85	271	138.33
	Saline	1228	930.62	207	110.76
One Shape	NaOCl	1214	392.68	328	135.71
	Saline	1094	416.14	164	89.73
Total	**NaOCl**	**1311**	**457.39**	**230**	**125.29**
	Saline	**1328**	**606.31**	**399**	**273.18**

ples every 1 week and the samples were incubated for four weeks in 37 °C. After the incubation period, the teeth were removed from the tube under laminar flow hood and mounted back on their gypsum blocks. A K-file no.15 was then inserted into the canal and the canal was filed for 10 s. Two teeth were not instrumented as positive controls. The samples from root canals were collected by placement of three paper point no. 20 each placed into the canal for 10 s. then the paper points were transmitted to tubes containing 5 µl BHI medium and vortexed for 30 min for serial dilution. Each dilution was then placed on BHI agar plates and incubated for 48 h in 37 °C. Then the colony forming units (CFU) were counted.

The samples were randomly assigned into four groups each instrumented with a different rotary system; RC, WO, OS, PT each containing 20 teeth. Each group was then subdivided to 2 groups based on irrigating solutions of normal saline and NaOCl 5.25%. The total volume of irrigant was 18 ml. Roots canals were irrigated with 2 ml of irrigating solution each time the instrument was changed with the use of needles attached to 5-ml luer lock syringes. Final rinse was performed by 10 ml of the irrigating solution. Instrumentation was performed using four rotary system based on company instructions:

1. RC: R25 file (tip size 25, 0.08 taper) was gently inserted into the cervical third of the root canal with in-and-out pecking motion. After three movements, the file was removed from the canal to clean the flutes. Then, the file was re-inserted in the same manner for the middle third. Lastly, the file was inserted at WL with a brushing motion against the canal walls.
2. WO: Primary file size 25, 0.08 taper was inserted into approximately two-thirds of the canal length with in-and-out pecking motion. After retrieval of the file, it was inserted again at WL with the same motion.
3. OS: Instrumentation was performed with a slight pecking motion until the WL has been achieved.
4. PT: Preparation was done by crown-down technique using the sequence of SX (at two-thirds of WL), S1 and S2 (at 1 mm short of the WL), and F1 and F2 (at WL) instruments. The files were passively used with in-and-out movements and also lateral brushing motion.

After instrumentation, the root canals were filled with BHI broth. *E. faecalis* can stay in the dentinal tubules and the samples should be filled with BHI broth and recollected after 60 days. Data was statistically analyzed by Statistical Package for the Social Sciences (SPSS, v 22, IBM, NY, USA) using descriptive statistics, Shapiro-Wilk analysis, and two-way analysis of variance. Level of significance was set at α=0.05.

Results

Shapiro-Wilk analysis confirmed the normal distribution of the data (P>0.1). Table 1 depicts the descriptive statistics of number of bacterial colonies before and after instrumentation and irrigation. Based on two-way analysis of variance the number of bacterial colonies before instrumentation and irrigation was not significantly different in the groups with different instruments (P=0.316) and irrigants (P=0.893). Reduction in number of bacterial colonies before and after instrumentation and irrigation was not significantly different in different rotary instrument systems (P=0.128, F=1.955). However, a statistically significant difference was observed in reduction of bacterial colonies between samples irrigated with normal saline and NaOCl (P<0.001, F=15.528) with NaOCl being more effective in reduction of bacterial load. Moreover, the amount of reduction in bacterial load using different irrigants was dependent on instrument type (P<0.001, F=18.551). In RC, PT, and WO systems NaOCl was more effective in reduction of bacteria than normal saline. While, in OS system normal saline showed higher reduction of bacteria compared to NaOCl, although not significant.

Discussion

According to the results of the present study, reduction of bacterial load was not significantly different in root canals treated with different rotary systems. However, use of NaOCl was significantly more effective in reduction of *E. faecalis* than normal saline.

In this study *E. faecalis* was used to evaluate and compare the effectiveness of four rotary systems and two irrigants in reduction of bacteria as a measure of canal disinfection. *E. faecalis* is present in persistent endodontic infections and is resistant to various protocols of root canal preparation and intracanal medicaments (16, 17). Moreover, it can survive in difficult environmental conditions (18). *E. faecalis* can also reside in infected root canals without the synergistic support of other bacteria in contrast to most other endodontic bacteria (19).
Machado et al reported that no statistically significant difference was found between PT and Mtwo rotary instruments in removal of *E. faecalis* from root canals (9).
Moreover, Martinho et al in their study concluded that WO, RC, PT, and Mtwo rotary endodontic systems are equally effective in reduction of endotoxins and cultivable bacteria from primarily infected root canals, although they were not able to eliminate them from all tested root canals (20).
Similar results were also observed by Machado et al in another study (21). These findings are consistent with the results of the present study as examined endodontic systems had similar effectiveness in reduction of *E. faecalis* from root canals.
However, Burklein et al reported that RC and Mtwo rotary systems are more effective in cleaning of the apical region compared to WO and PT (11). As their result was not observed in other similar studies, further evaluation might be needed to elucidate any possible difference between various rotary systems.
Different designs of rotary systems may alter the efficiency of these files in bacterial reduction. More aggressive removal of dentin would eliminate more bacteria from the root canals (22). Also, the size of apical enlargement is important in the amount of reduction of intracanal bacteria (23).
Practitioners must consider that regardless of the endodontic system used for cleaning and shaping of root canals, dentinal walls must be removed and proper apical preparation must be performed to ensure maximal reduction of bacteria from the root canals.
Siqueira et al stated that although both ro-

tary and hand instrumentation techniques were significantly effective in reduction of bacterial population, however, in all cases NaOCl was more effective in elimination of bacterial load from root canals compared to normal saline (24).
This finding is also similar to the results of the present study. Studies suggest that the antimicrobial effect of NaOCl is not significantly different in 0.5% to 5% solutions (25-27).
The frequency and the volume of NaOCl can compensate the differences in solution concentration. However, complete elimination of bacteria may not be possible regardless of concentration, frequency, and volume of irrigants (24).
Although reduction of bacterial load is reported in many studies following the use of hand or rotary instruments, complete elimination of bacteria such as E. faecalis is not possible (28). Therefore, adequate use of irrigants is important when cleaning and shaping is done by any method.

Conclusions

Under the conditions of this study reduction of bacterial load was not significantly different in root canals treated with different rotary systems. However, use of NaOCl was significantly more effective in reduction of *E. faecalis* than normal saline.

Clinical Relevance

Elimination of bacteria from the root canal system is the primary goal of endodontic treatment. Although Reciproc, Wave One, Protaper, and One Shape rotary files used in this study were not significantly different for this purpose, NaOCl was more effective in bacterial reduction compared to normal saline.

Conflict of Interest

The authors deny any conflict of interest.

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