An Ex Vivo Study to Assess and Compare the Microbial Load Reduction in Oval Shape Canals after Instrumentation with TruShape 3D, Xp Endo Shaper

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OBJECTIVES: The oval-shaped canals are challenging to clean as the cross-section of the canals is oval and the file is triangular making cleaning and shaping a challenge. This enables bacteria and organic debris to cause pathogenesis of apical periodontitis in root canal treated teeth. The TruShape 3D and Xp Endo Shaper have improved metallurgy that imparts greater flexibility. The present study has focused on the ability to disinfect root filled teeth.

METHODOLOGY: Based on the radiographic criteria the teeth with oval-shaped canals were selected and using the E faecalis strain 29212 they were inoculated with using BHI in tubes placed in an incubator. After 4 weeks the teeth were divided into 3 groups : Group 1: TruShape 3D, Group 2: Xp Endo Shaper and Group 3: Protaper Gold. Baseline sampling S1 was done, after instrumentation S2 sampling was done. The paper points were used that were plated on Columbia agar with sheep blood and then the colonies were counted.

RESULTS: The One Way Anova , Tuckeys post Hoc tests were used . The results were statistically significant. Protaper had 60% percentage decrease in CFU, TruShape 3D showed 57% decrease and 55% decrease was reported for XP Endo Shaper.

CONCLUSION: TruShape 3D is more suitable for oval-shaped canals than XP Endo Shaper, However more studies are required on this topic.

KEYWORDS: Oval-Shaped Canals,TruShape 3D, Xp Endo Shaper

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INTRODUCTION

The hallmark of successful endodontics is to achieve three-dimensional disinfection of the root canal space. The remnants surviving the chemo-mechanical preparation aid in the pathogenesis of apical periodontitis in root canal treated teeth.[1] The advancements in file systems, irrigation systems and intra canal medicaments are all aimed at improving the quality of the chemo-mechanical preparation of the root canal space.

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The oval shaped canals are mostly found in incisors and premolars. They are defined according to the radiographic criteria of bucco lingual diameter being 2-2.5 times greater than the mesio distal diameter.[2] The cleaning and shaping of oval-shaped canals is troublesome as the cross-section of the canal is oval whilst the surface of revolution of the file is circular that renders the extremities unaffected which harbor the bacteria which synthesize into a biofilm and cause apical periodontitis.[2,3]

The TruShape 3D file system is a heat treated NiTi that during activation changes to S-Shape in order to get in contact with 75% of the canal walls preserving more dentine.[4] XP endo shaper is made from MaxWire technology that involves Austenite-Martensite electropolish it has an initial taper of 0.01 that on contact with 37 degree Celcius changes to 0.04. Post activation the diameter of XP Endo Shapers changes from 0.15mm to 0.30 mm.

E faecalis is being used as a test microbe for its role in the pathogenesis of apical periodontitis.[5] Micro Computed tomography based comparison of the quality of preparation done by XP Endo Shaper (30/0.04) and TruShape 3D (20/0.04, 25/0.04 and 30/0.04) reveals no significant differences between the single file system and multiple file systems.[6] XP Endo Shaper showed a better quality of canal preparation when used for a period of extended activation of 45 seconds.[7]

The results of a culture based study have shown that XP Endo Shapers and Hyflex EDM have proven to be better than Wave One Gold in debridement of bacteria from infected canals. The present study evaluated the manufacturers' claim that TruShape 3D achieves 75% contact with canal walls by examining its efficacy in microbial load reduction. The null hypothesis tested posits that the XP-endo Shaper, TruShape, and ProTaper systems exhibit similar effectiveness in reducing bacterial load from oval canals.

METHODOLOGY

The study protocol was approved by the Institutional Review Board of DUHS vide approval no:(IRB-2092/DUHS/Approval/2021/435). The sample size calculation were done by computing the values of mean and standard deviation given in the reference article 8 on the Open Epi version 18 . The sample size calculated was 85 but we conducted study on 100 teethThe teeth were used in accordance to the DUHS policy for the use of extracted teeth for research purpose where the permission is sought from patients for usage of teeth for research and then stored in a tooth bank. Lower premolars with a buccolingual diameter two times greater than the mesiodistal diameter and the teeth with an initial binding of #15k file were selected.Teeth with the following features were excluded:

1. Teeth with root fractures or cracks.
2. Root Resorption
3. Root caries
5. No patency
6. curved canals.

INITIAL SAMPLE PREPARATION

The crowns of all the selected teeth were sectioned at the cement-enamel junction using a diamond bur in a high-speed hand piece. All the roots were standardized to 17mm. Patency was established using a 10k file up to the level of the apical foramen, this length was measured and the working length was established 1mm short. Each canal was irrigated with 5% sodium hypochlorite with a 30 gauge side vented needle and stored in 10% sodium thiosulphate(4 hours) and saline (20 hour) to neutralize the effect of sodium hypochlorite. The apices were sealed with nail varnish.

STERILIZATION

The roots were sterilized using an autoclave at 121 degrees for 15 minutes after placing each one in a 1.5mL Eppendorf tube with sterile Brain Heart Infusion broth. Later they were kept in an incubator at 37 degrees for 48 hours to ensure that there is no bacterial contamination. The roots were divided into four groups based on the instrument being used as follows:

Group 1 TruShape 3D, n=30
Group 2 XP-endo Shapers, n=30
Group 3 Pro Taper Gold, n=30

BACTERIAL INNOCULATION

A 0.5 MCFarland suspension was prepared in a Brain Heart Infusion broth and then diluted 30 times to obtain a suspension of 1×10^7 CFU per milliliter. Each canal was then filled with 10 µl of the E faecalis (strain 29212) suspension in sterile micro pipettes (10µl) and 15k files was used to transfer them all the way to the working length. The roots were incubated at 35 degree centigrade with 95% humidity for 4 weeks where the BHI was then replaced every 48 hours under laminar flow.

INITIAL SAMPLING

Initially the canals were rinsed with sterile saline and then two of number fifteen paper points were soaked upto the working length for a minute and then stored in a container with 0.85% saline to get the initial value of sampling (S1).

INSTRUMENTATION

TruShape 3D(Dentsply): The working length was predetermined and is kept 1mm short of the apex. Initial filling was done with the orifice modifier (20/0.08 taper) in pecking motion, the file was withdrawn when resistance was felt, followed by 20/0.06v, 24/0.06v and 30/0.06v. During and after the filling process the canals were irrigated with sterile saline using a side vented needle placed 1mm short of apex.

XP-endo Shaper: The XP Endo Shaper was used in light up and down movements till it reached the working length without giving any resistance (800 rpm and 1.0Ncm). For

the purpose of irrigation, a side vented needle placed 1mm short of apex at a temperature using saline heated of 37 degree centigrade was used(the temperature was maintained at 37 degrees using a water bath that was kept in an incubator set at 37 degrees)

Pro Taper Gold: Canal preparation was started with light brushing motion to shape the canal with the SX file and followed the sequence S1, S2, F1, F2, F3. Irrigation was performed with sterile saline using a side vented needle.

MICROBIAL SAMPLING S2

After preparation was complete the #25 paper points were soaked upto the working length and stored in a container with 0.85% saline for microbial sampling.

QUANTIFICATION OF BACTERIAL LOAD

The paper points were placed in tubes containing 1 mL of 0.85% saline solution and vortexed for 1 minute. After 10 fold serial dilution, 0.1ml aliquots of each sample were placed on a CA-SB(Columbia agar with sheep blood) agar plate and incubated at 35 degrees for 24 hours, the Colony Forming Units were counted and then using dilution factors, the actual counts were calculated using the formula (no of microbes=no of colonies× dilution factor)

RESULTS

The SPSS version 16 was used for the purpose of statistical analysis. The data followed normal distribution (on basis of Shapiro Wilk test). Later the values of mean and standard deviation were calculated. Using the means for S1 and S2 for the file systems (ProTaper, XP-endo Shaper and TruShape 3D) . Table 1 shows the values of CFU/ml for S1 (right after inoculation).

Table 1

Group	N	CFU_a
Protaper	30	$5^x \pm 2^x$
Xp-Endo Shaper	30	$9^x \pm 2^x$
TrueShape 3D	30	$7^x \pm 3^x$

a: values reported as mean ± standard deviation, CFU: Colony Forming Units, x= value$\times 10^{15}$, x represents values $\times 10^{15}$, G:group

The Table 2 shows the levels of CFU/ml present in the canals after instrumentation with Protaper F3(positive control) XP Endo Shapers and TrueShape 3D (30/0.04). The percentage decrease was tabulated and the P-values were generated using the One way Anova. Table 3 shows the results of the Post-Hoc tests.

Table 2

Group	p-value#
PT and XP	<0.001
PT and TS	0.002
XP and TS	0.046

CFU: colony forming units, a: values represent mean± standard deviation.

Table 3: Shows the results of the Tuckeys Post Hoc test

Group	N	cfu[a]	% decrease	p-value
Protaper	30	$2^x \pm 1^x$	60	<0.001
Xp Endo Shaper	30	$4^x \pm 1^x$	55	<0.001
TrueShape 3D	30	$3^x \pm 2^x$	57	<0.001

CFU: colony forming units, a: values represent mean± standard deviation.

DISCUSSION

Previous studies related to root canals have employed two main methodologies: Micro CT and Microbial culture. The Micro CT based studies have examined the intricate geometrical changes after canal preparation whilst the Microbial culture based studies have provided changes in bacterial CFU after chemo-mechanical preparation. The present study had investigated the effect of mechanical preparation on reduction of bacterial count in controlled conditions. The chemo-mechanical preparation of oval-shaped canals is challenging on account of the anatomic configuration of the canal space. The present study is in congruence with the study of Morales et al who concluded that XP endo Shaper, Trushape 3D (20,25 and 30) were similar in terms of canal preparation in a micro-ct based study.

The null hypothesis was rejected in the present study. The Protaper Gold showed a 60% reduction, 55% reduction was shown by XP Endo Shaper and 57% by TruShape 3D files.The present study used the protocol used by Ureyen Kaya et al.[8] in their study, in this study some of the roots were sectioned and scanned using the Scanning Electron Microscope , the scans showed development of bacterial biofilm of E faecalis. With the presence of positive values at S1, turbidity in tubes after 48 hours we can assume that biofilm was established in the present study.

In the present study there were two operators , one was a trainee of endodontics and the other was a microbiologist who performed the bacterial culture and the microbiologist was completely blinded of the technical aspects of the study. However the aspect of operators bias can't be completely

ignored in the present study.

The XP Endo Shaper are sensitive to temperature the activation of the booster tip at 37 degree celcius is imperative for optimum performance. A 55% decrease in bacterial CFU has established that XP Endo Shapers were activated by the pre-heated saline. The Protaper system is considered gold standard in rotary endodontics hence it is used as a control group. The potential of Xp Endo Shaper for microbial load reduction in straight and round canals was investigated in a previous study. A 86% decrease in Colony Forming Units was observed in that study. This difference can be attributed to anatomic configuration of the oval-shaped canals howsoever it is imperative to understand that both studies have used heated saline instead of sodium hypochlorite as an irrigant.

The TruShape 3D files have an S-Shaped configuration during activation and it gets in contact with 75% of the canal walls during activation. An ex vivo study comparing the effect of canal preparation of twisted file, Tru Shape 3D on microbial load reduction with and without an irrigant concluded that Tru Shape 3D in absence of anti-microbial irrigant showed a 99% reduction in bacterial CFU, this study had a sample size much lesser than that of the present study.[9]

The present study can't be likened to clinical conditions as sodium hypochlorite wasn't used. The sodium hypochlorite antagonizes colony forming units in infected oval shaped canals independent of the concentration used from 2mins till 6mins.[10] Easy clean, Endo Activator and Passive Ultrasound Irrigation showed upto 99% decrease in Bacterial CFU.[11] The use of micro CT and cone-beam CT would have been more accurate in determination of canal morphology. Also the use of a biofilm model would have been more accurate in assessment of microbial load reduction.[12] The findings of the present study will not be significant for greater apical sizes.The XP Endo Shaper had shown a 55% decrease in microbial colony forming units while Tru Shape 3D showed a 57% decrease, these statistically significant differences prove that TruShape 3D is superior however these findings could change if a greater sample size is used. The difference between the two groups although significant is small because of greater flexibility and ability of XP Endo Shaper to extend beyond its core.[13] The study validates the findings of Micro CT based studies which claim that none of rotary files were able to prepare the entire surface area of oval-shaped canals.[14,15,16,17]

CONCLUSION

The TruShape 3D files showed a 57% decrease in microbial CFU while XP Endo Shaper showed a 55%.

CONFLICT OF INTEREST

None to declare

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