https://doi.org/10.48047/AFJBS.6.13.2024.4855-4865

African Journal of Biological Sciences

Journal homepage: http://www.afjbs.com

Research Paper Open Access

Analysis of root canal volume changes with OneShape. Standard Mani Silk & Blueflex Acerfile using CBCT: An in vivo study

[1]Dr. Mandeep Kaur, [2]Dr. Renu Bala Sroa, [3]Dr. Baljeet Kumar, [4]Dr. Sukhman Singh Sran, [5]Dr. Nisha, [6]Dr. Yashika Bhambri

[1,5,6]Post-Graduate Student, [2]Professor and Head, [3]Associate Professor, Department of Conservative Dentistry & Endodontics, Punjab Government Dental College &Hospital, Amritsar, Punjab, India
[4]Graduate Student, Sri Guru Ram Das Institute of Dental Sciences & Research, India

Corresponding Author: Dr. Mandeep Kaur, Post-Graduate Student, Department of Conservative Dentistry & Endodontics, Punjab Government Dental College &Hospital, Amritsar, Punjab, India

Article History

Volume 6, Issue 13, July2024

Received: 23 June 2024

Accepted: 28 July 2024

doi: 10.48047/AFJBS.6.13.2024.4855- 4855

ABSTRACT

Objective: The aim of this in-vivo study was to evaluate the changes in canal volume after root canal preparation with three different file systems i.e. OneShape, Standard Mani Silk and Blue Flex Acerfile using CBCT and 3D reconstruction.

Method: Forty-five permanent mandibular premolar teeth were selected and divided into three experimental groups i.e. Group I (OneShape), Group II (Mani Silk File) and Group III (Blueflex Acerfile) compromising of fifteen teeth each. CBCT scans before and after root canal preparation were taken and stored in DICOM format. The DICOM files were sent to the second workstation for 3D reconstruction and pulp segmentation with BlueSkyPlan software. Segmented models were exported as STL file. Using 3D MeshMixer software, canal volume from CEJ to the apex of the tooth before and after preparation were calculated and results of the structure were obtained in mm^3 in tabulated form. Student's t test for paired data was used to determine statistically significant difference between the before and after canal volumes. One way ANOVA test was used to determine statistically significant differences in the percentage of canal volume increase between the groups and Tukey's post-hoc test was used for paired comparison.

Result: The comparison between initial canal volume of the canal prior to the instrumentation procedureand the final volume after preparation showed statistically highly significant difference in all three groups($p<0.001$). Statistically significant difference was found betweenOneShape file,Standard Mani Silk file and Blueflex Acerfile ($p<0.05$).

Conclusion: Blueflex Acerfileshowed higher increase in the root canal volume as compared to OneShape file, while Standard Mani Silk file showed minimum change in the canal volume during preparation.

Keywords: OneShape file; Standard Mani Silk file; Blueflex Acerfile; CBCT;canal volume;DICOM format; BlueSky Plan software and MeshMixer software.

INTRODUCTION

Modern endodontic therapy has been dominated by the endodontic triad with the goals of achieving complete debridement, sterile root canal trench and obturation of canal in three dimensions for the successful outcomes. Optimal endodontic preparation aims to preserve the original morphology of the root canals.The internal cross-section anatomy of root canals has various shapes and sizes which makes it difficult to clean and disinfect. Deviation from the initial root canal curvature can cause excessive and inappropriate dentin removal, effects the success of endodontic treatment.

Development of nickel-titanium (NiTi) rotary instruments provided easier and faster root canal instrumentation.The incorporation of the new design features such as varying tapers, non-cutting safety tips and varying length of cutting blades has resulted in new generation of instruments.NiTirotary fileswith the modified geometries, asymmetrical rotary motion, the reciprocating movement, and advancements in the thermomechanical treatment of the alloys, improve the adaptation of endodontic files to the root canal anatomy while maintain its original shape.Single-file shaping technique simplifies the instrumentation protocol while reducing the risk of instrument failure and cross contamination **(Agarwal RS et al 2015)**.

OneShape File (Micromega, Besancon, France) is the single rotary file system that operates in continuous rotation motion. Its high cutting efficiency, flexibility and noncutting safety tip with variable pitch which reduces screwing effects. It has three variations of cross - sections along its active length: a changing cross-sectional zone with 3 sharps cutting edges in the apical and middle part and S-shaped with 2 cutting near the shaft.OneShape preserved the original canal path, maintains a continuous, safe and adequate shape and taper of the root canals **(Berchet D et al. 2018).**

The Standard Mani Silk (Mani Prime Dental products, Japan) is a two -file system having a tear-drop cross-section with a positive rake angle, possess flexibility, cutting efficiency, and fracture resistance because of its design and heat treatment. It removes debris efficiently and reduces instrument stress. Manisilk files in reciprocating motion provide superior centering ability and less canal transportation than manual and rotary protaper files(**Bhavthankar A et al. 2018).**

Recently a new file system, **Blueflex Acerfile(Bluedent Innovations Pvt.Ltd., India),** manufactured using blue wire technologywith greater resistance to cyclic fatigue, cutting efficiency, flexibility andcauses less damage to dentin. It is available in various sizes and tapers. It is It has safety tip which ensures no apical perforation and 400% less chances of breakage. This new file system requires low-torque value which enhanced the safety of rotary files. **(Patel D et al. 2021).**

Numerous methods have been used to assess the shaping ability of endodontic instruments in terms of canal volume and the changes in canal morphology including radiography, stereomicroscopy, computed tomography (CT), cone-beam (CBCT) and micro-CT. Micro-CT has been considered as main tool in most of the studies to evaluate root canal preparation. However, this technology is inapplicable in patients to scan teeth. CBCT is a modification of the former computed tomography (CT) systems. The CBCT is a reproducible method that captures data directly from the patient by using a cone-shaped X-ray beam. It reconstructs 3D image of soft and mineralized tissues without causing any harm to tooth anatomy, such as obtaining high resolution images, lower radiation dose, short scanning time and reduced cost.The use of CBCT allows to measure the volume of the prepared and unprepared area, surface area and clarify the anatomy of the root canal.

Therefore, the purpose of the present in-vivo study was to evaluate changes in canal volume after root canal preparation with three different file systems i.e. OneShape, Standard Mani Silk file and Blueflex Acerfile, using CBCT and 3D reconstruction with BlueSky Plan software.

METHODOLOGY

A Prospective in vivo experimental research was conducted after recommendations from the Faculty of Dental Sciences regarding ethical issues in research. It was approved by the Dental Research Ethics Committee of the Punjab Government Dental College and Hospital, Amritsar affiliated to Baba Farid University of Health Sciences, Faridkot(No. BFUHS/2k22/p-TH/766). Written consent from each patient participating in the study was taken along with a detailed history before the procedure.

INCLUSION CRITERIA

1. Teeth with single root.
2. Teeth with one straight canal.
3. Teeth with canal curvature < 25º.
4. Age of the patient 18-45 years.
5. Teeth with no previous restoration.
6. The mandibular premolar with mature apices.
7. Teeth with no history of previous endodontic treatment.
8. Clinically and radiographically, teeth without sign of periodontal disease or traumatic occlusion.

EXCLUSION CRITERIA

1. Teeth with gross carious lesions.
2. Teeth with fracture of the root or crown only.
3. Presence of any major systemic disorder.
4. Teeth with abnormal anatomy.
5. Teeth with incomplete root formation.
6. Teeth with internal or external resorption and calcified canals.
7. Periodontal pockets over 4 mm deep.

PRE-INSTRUMENTATION SCANNING

Theinitial CBCT scanwas taken with the PaX-i3D GreenTM PHT-60CFO (Vatech Co. Limited /Seoul, South Korea) with 95 KVP voltage, 6 mA current, resolution 0.08x0.08x0.08mm, field of view (FOV) 50mm X 50mm and dimension 632x632x632 pixels using Ez3D-i software.The scan time was approximately10sec.foreachpatient.Thestandardizationswereasfollows:apical third of the root canal was measured at 3mm; middle third of the canal was measured at 5mm and coronal third of the root was measured at 7 mm from the root apex. Images of the selected premolars were stored in Digital Imaging and Communications in Medicine (DICOM) format.

ISOLATION AND FIELD DISINFECTION

Allpatientsunderwentprophylaxiswithchlorohexidinegluconateoralrinsesolution. Mandibular teethwereanesthetized withaninferioralveolarnerveblocktechnique using 1.8ml of 2% Lignocaine and 1:200000 adrenaline (Dental Genie,India).The teeth were isolated using a rubber dam (Coltene, Switzerland).

CLINICAL PROCEDURE

Endodontic access cavity was prepared at high speed by using sterile no.4 round bur (Mani,Japan) and endo Z bur (Prima Dental,United Kingdom).Canal patency was confirmed with No.10 K- type file (Mani,Japan).The working length (-0.5mm from apical foramen) was

determined using an apex locator Root ZX (J Morita, Japan) and verified with a periapical radiograph.

ROOT CANAL PREPARATION

According to the method of instrumentation used, the selected 45 mandibular premolar teeth were divided into three groups:

Group I: OneShape (Micromega,Besacon,France)

Group II: Standard Mani Silk File (Mani Prime Dental products, Japan)

Group III: Blueflex Acerfile (Bluedent Innovations Pvt.Ltd., India) comprising of fifteen teeth each.

GROUP I: PREPARATION WITH ONE SHAPE FILE

The selected teeth in these groups were prepared using the OneShape file system (Micromega, Besancon, France) consisting of a tip size of 25 with 6% taper activated in Endodontic electromotor (Coltene, Whaledent, Switzerland) in continuous rotation motion at 400 rpm and a torque of 2.0 Ncm.The file was used with up and down pecking motion with amplitude of 3mm until cervical and middle third of canal was prepared. After 3 up and down pecking movements, the file was removed and cleaned with wet gauze to remove the dentin debris and then reinserted.The canal was irrigated with 3ml of 5.25% sodium hypochlorite (NaOCl) using a syringe with a 30-gauge needle placed 2 mm short of working length. Then, a final flush with 10ml sterile distilled water was used.

GROUP II: PREPARATION WITHSTANDARD MANI SILK FILE

The selected teeth in these groups were prepared by Standard Mani Silk File (Mani Prime Dental products, Japan) up to tip size of 25 with 6% taper (sequence: 25/.08, 20/.06, 25/.06) activated in Endodontic electromotor (Coltene, Whaledent, Switzerland) in reciprocating motion at 500 rpm and a torque of 3.0 Ncm.The file was used to prepare the cervical third and middle third region of the canal by pecking up-down motions with an amplitude of 3 mm .Following three up-down pecking motions, the file was removed and cleaned with moist gauze to detach the dentin particles before being reinserted. This procedure was repeated till it reached the working length.Irrigation volume of 5.25% sodium hypochlorite and sterile distilled water were same as described for Group I.

GROUP III: PREPARATION WITH BLUEFLEX ACERFILE

The selected teeth in this group were prepared using Blueflex Acerfile (Bluedent Innovations Pvt.Ltd., India) up to tip size of 25 with 6% taper (sequence:17/0.4,20/0.4,20/0.6,25/0.4,25/0.6) activated in Endodontic electromotor (Coltene, Whaledent, Switzerland) at 300 rpm and a torque of 2.0 Ncm.The file was used to prepare the cervical third and middle third region of the canal by pecking up-down motions with an amplitude of 3 mm.Following three up-down pecking motions, the file was removed and cleaned with moist gauze to detach the dentin particles before being reinserted.This procedure was repeated till it reached the working length.Irrigation volume of 5.25% sodium hypochlorite and sterile distilled water were same as described for Group I.

POST- INSTRUMENTATION SCANNING

After mechanical preparation, a second CBCT scan was taken with the PaX-i3D GreenTM PHT-60CFO (Vatech Co. Limited /Seoul, South Korea) with same parameters.

VOLUME ASSESMENT USING BLUE SKY PLAN SOFTWARE

All CBCT images (basis images) of pre- and post-instrumentation scan were stored as DICOM (Digital Imaging and Communications in Medicine) file .The obtained basis images were transferred to the second workstation that was IMAGE 3D CONVERSION company (https://image3dconversion.com/about.php) where they assessed the data. The DICOM images were imported into the open-source software BlueSkyPlan (BlueSkyBio,United States) for image reconstruction and to achieve the pulp segmentation. This software delineates the region of interest, isolate the tooth to be investigated, using the Multiplaner reconstruction (MPR) axial, coronal and sagittal planes. Following the completion of the pulp segmentation process, 3D MeshMixer software generated a three-dimensional (3D) model as well as a table displaying the volume of the structure in mm^3, which was calculated. The canal volume in Group I, Group II, Group III was measured before and after preparation from CEJ to the apex of the tooth.(Fig.1,2,3).

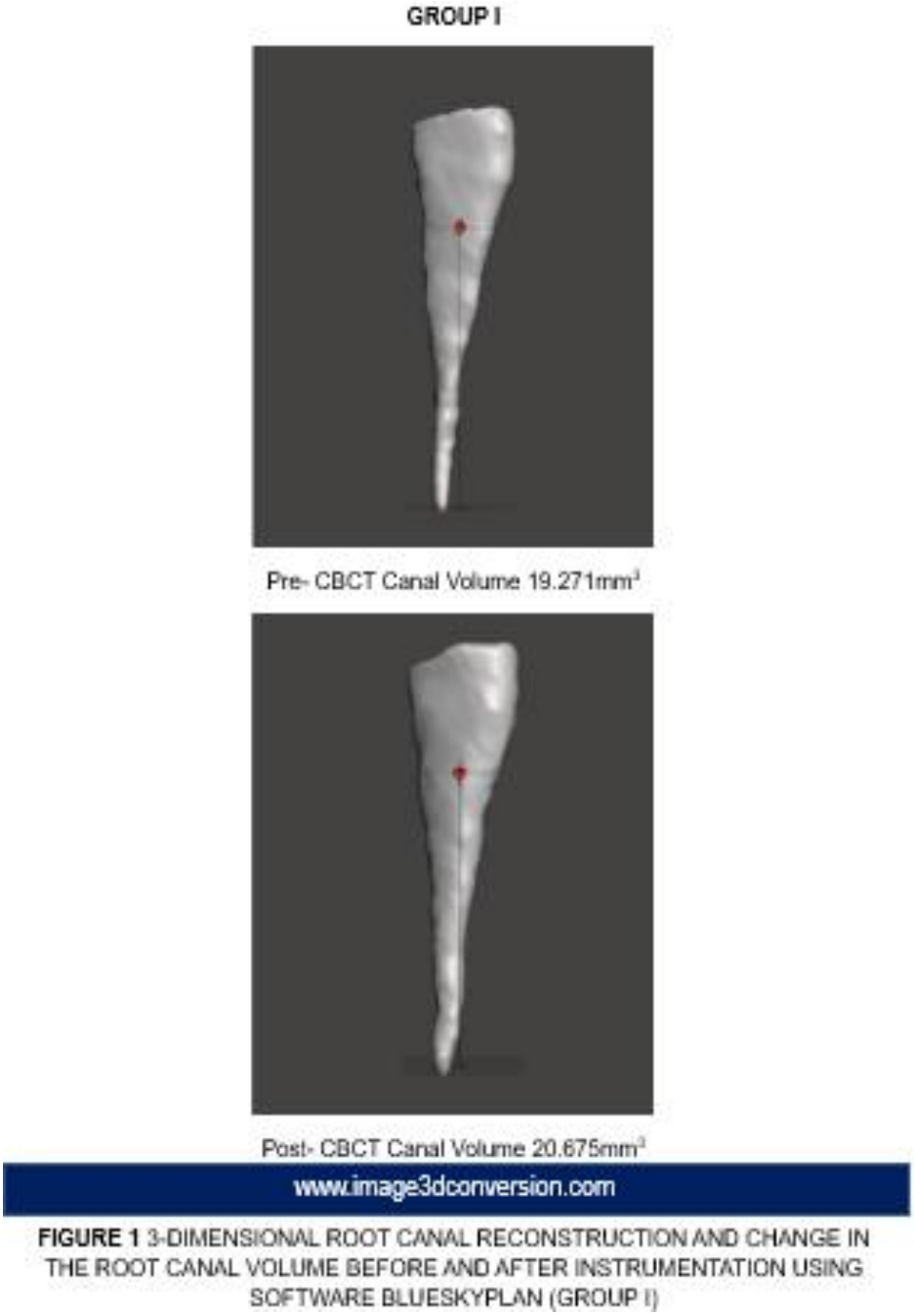


FIGURE 1 3-DIMENSIONAL ROOT CANAL RECONSTRUCTION AND CHANGE IN THE ROOT CANAL VOLUME BEFORE AND AFTER INSTRUMENTATION USING SOFTWARE BLUESKYPLAN (GROUP I)

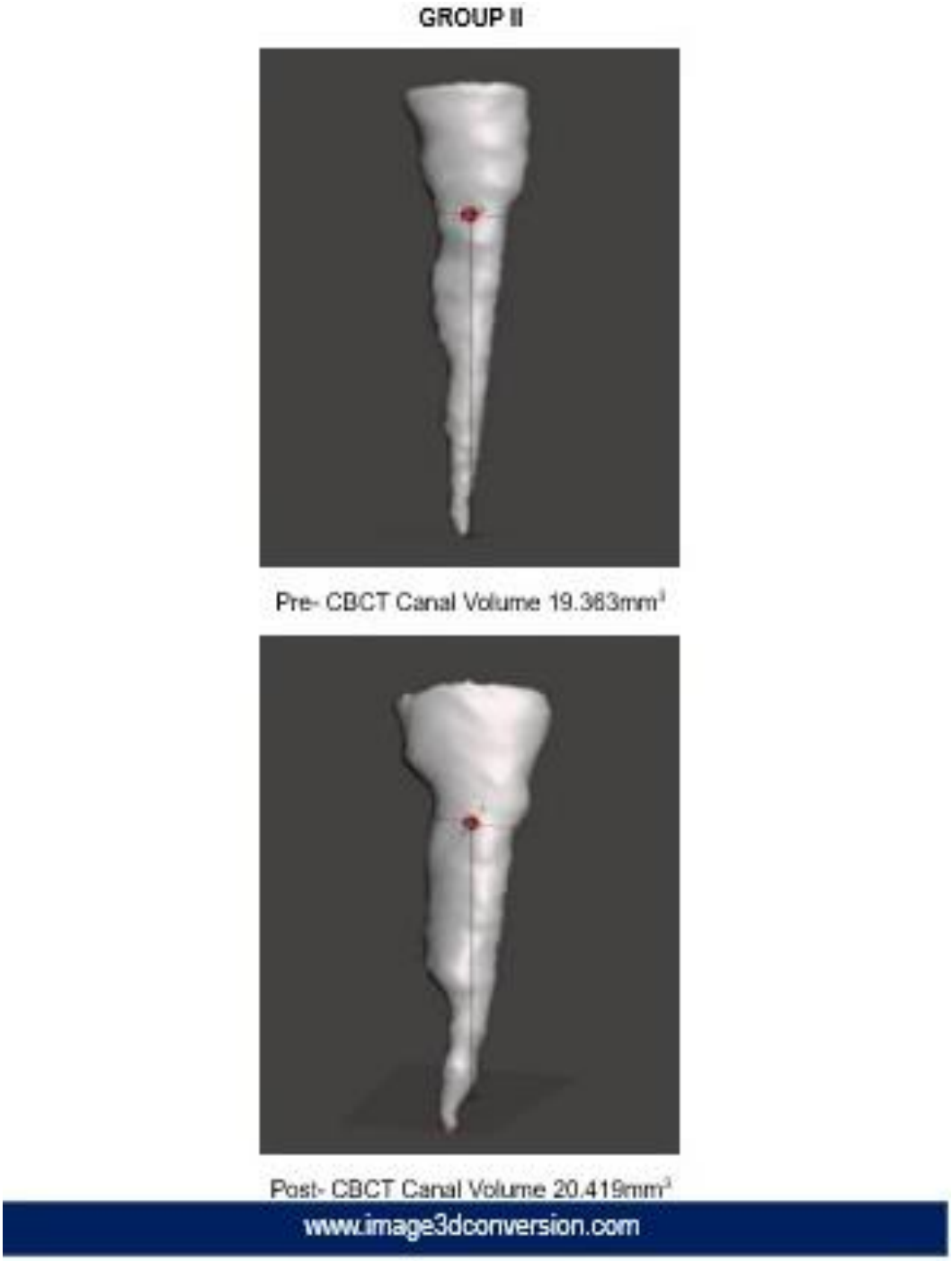
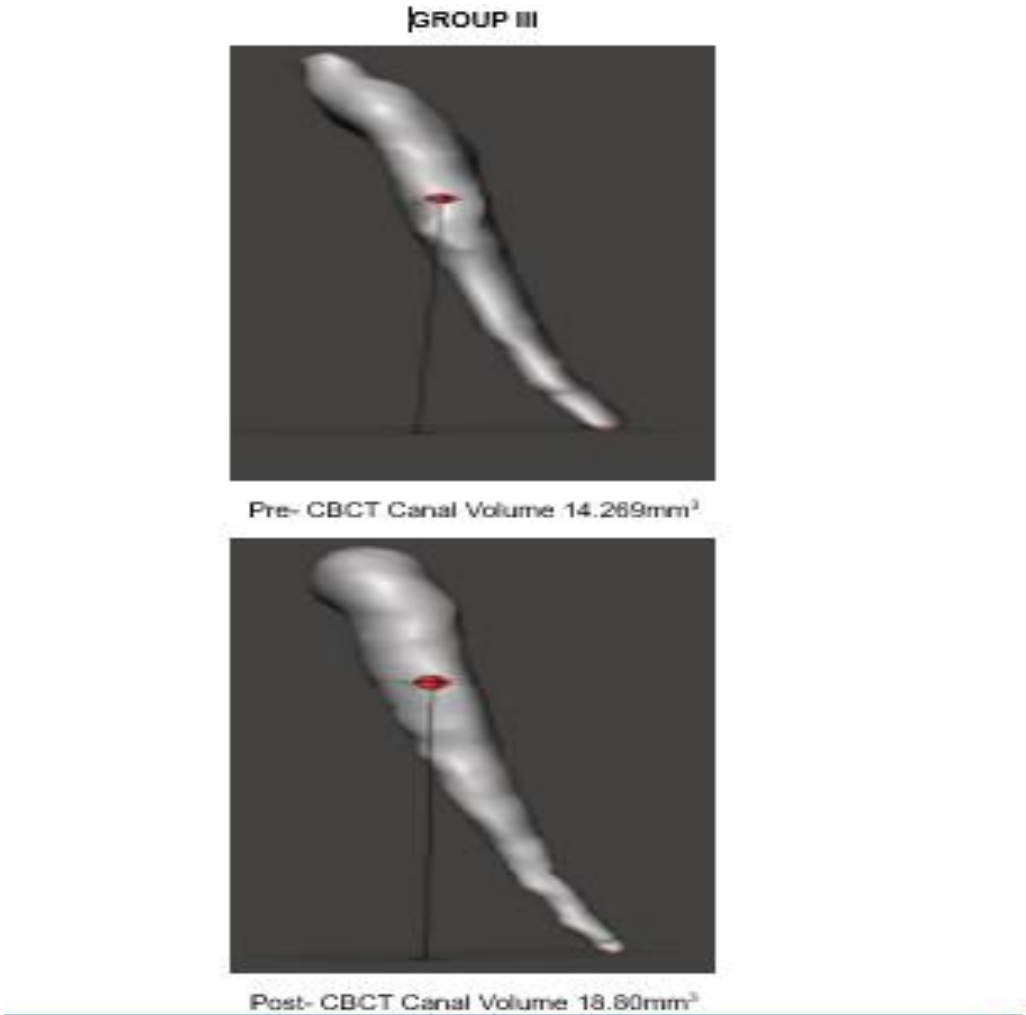


FIGURE 2 3-DIMENSIONAL ROOT CANAL RECONSTRUCTION AND CHANGE IN THE ROOT CANAL VOLUME BEFORE AND AFTER INSTRUMENTATION USING SOFTWARE BLUESKYPLAN (GROUP II)



GURE 3 3-DIMENSIONAL ROOT CANAL RECONSTRUCTION AND CHANGE IN HE ROOT CANAL VOLUME BEFORE AND AFTER INSTRUMENTATION USING SOFTWARE BLUESKYPLAN (GROUP III)

STATISTICAL ANALYSIS

The student's paired t testwas used to determine statistically significant differences between before and after canal volumes. ANOVAtest was used to determine statistically significant difference in the percentage of canal volume increase between the experimental groups. Finally, Tukey's HSD post-hoc tests were used forpaired comparisons between groups.

RESULTS

Table 1 shows the comparison between the initial volume of the canal prior to the instrumentation procedure and the final volume after preparation($p<0.001$).

TABLE-1 COMPARISON OF CANAL VOLUME BEFORE PREPARATION AND AFTER PREPARATION USING PAIRED 'T' TEST

Group	Before preparation		After preparation		Mean difference	p-value
	Mean	SD	Mean	SD		
I (One shape file)	15.318	1.213	20.043	2.83	-4.725	0.001
II (Standard Mani silk	15.289	1.941	18.003	2.377	-2.714	0.003

file)						
III (Blue flex acerfile)	14.314	3.142	20.973	6.598	-6.659	0.001

Significant level: P<0.05 (Significant); <0.001 (Highly significant); >0.05 (non-significant)

In addition, the percentage of canal volume increase was calculated after preparation with each system using One way ANOVA test. Table 2 shows that Blueflex Acerfile (Group III) produces the largest canal volume increase with a mean percentage change of 28.799% ± 13.4%, followed by OneShape file (GROUP I) with a mean percentage change of 19.870% ± 7.6%. Standard Mani Silk file (GROUP II) showed least canal volume increase with a mean percentage change of 14.440% ± 9.4% at 95% confidence interval.

TABLE 2: PERCENTAGE OF CANAL VOLUME INCREASE AFTER PREPARATION WITH THREE DIFFERENT SYSTEMS USING ONE WAY ANOVA

Group	N	Mean	SD	S.E of mean	95% C.I.	Minimum	Maximum
I (One shape file)	15	19.870	7.603	1.885	14.826-22.915	6.791	31.377
II (Standard Mani silk file)	15	14.440	9.408	2.429	9.230-19.650	3.191	31.392
III (Blue flex acerfile)	15	28.799	13.413	3.463	21.372-36.228	9.596	68.289

Tukey's test post-hoc comparisons revealed statistically significant differencesbetween OneShape , Standard Mani Silk and Blueflex Acer file systems (p<0.05) (Table 3).

TABLE-3 INTER-GROUP MULTIPLE COMPARISON OF CANAL VOLUME CHANGE USING POST-HOC TUKEY HSD TEST

Group	Mean difference	Standard Error	95% confidence interval		P Value
			Lower	Upper	
I/II (OS/SMS)	4.725	1.334	-3.120	6.640	0.032
II/III (SMS/BFA)	-3.945	1.334	-7.185	-0.705	0.014
III/I (BFA/OS)	-1.934	1.334	-6.365	0.015	0.046

Significant level: P<0.05 (Significant); <0.001 (Highly significant); >0.05 (non-significant)

DISCUSSION

The cardinal goals of chemo mechanical preparation are to thoroughly debride and shape the root canal while maintaining the natural anatomy. Various approaches such as instrumental designs and thermomechanical processing techniques were used to improve mechanical properties of rotary and reciprocal Ni-Ti files to enhance the adaptation to the root canal and minimize the damage to dentinal walls.

The present study evaluated the change in root canal volume after preparation with three different NiTi files i.e.OneShape, Standard Mani Silk file and Blueflex Acerfile in mandibular premolars using CBCT.

Several technologies, including histological sections, scanning electron microscope, CBCT, and micro-CT, are currently utilized to reconstruct the anatomy of the original root canal in order to evaluate root canal preparation. However, it is impossible to use micro-CT in human in-vivo experiments to scan teeth. CBCT is an evolution of the micro-CT that is less intrusive, produces high-resolution, and accurate three-dimensional images.

The present study used CBCT as a less-invasive tool,that provides reproducible high resolution and accurate three-dimensional images, allowing to compare the initial root canal morphology with the canal anatomy after preparation. The images obtained were digitized with the BlueSky Plan software, for the reconstruction of the root canal through measurements obtained from the tomographic slices. This software offers a practical way to capture 3D measurements of study models, generate tooth segmentation, its accuracy and dependability allow for realistic and effective measurements (BlueSkyBio,).3D MeshMixersoftware was used because it analyse thevolume,thickness and orientation of the model(3Dnatives).

The initial volume of the pre-instrumented canals was similar for the three preparationsystems, with no significant differences between the groups. This is important to verify that three systems worked under similar conditions to reduce variation in results.Following instrumentation with OneShape file, Standard Mani Silk file and Blueflex Acerfile showed statistically highly significant difference in the canal volume change of the entire root canal space. Similarly, **Elashiry MM,Saber SE and Elashry SH (2020)** found that there was a significant difference in canal volume change after instrumentation with four different single file systems.

The results of the present study revealed thatBlueflex Acerfile presented largest canal volume increase (28.799% ± 13.4%) in comparison to OneShape file (19.870% ± 7.6%) and Standard Mani Silk file (14.440% ± 9.4 %). This may be explained due to its triangular cross-sectional design, larger flares, variable pitch and greater taper with continuous rotational motion which promotes more dentin removal.Theincrease in canal volume was lower for OneShape file than for Blueflex Acerfile, probably due to the threedistinctcross-sectionzoneswiththree cutting-edge at the tip region and two cutting-edge at the shaft region of OneShape filethat offers optimal cutting action and less removal of dentin.The Standard Mani Silk file presented the smallest canal volume increase (14.440% ± 9.4 %) of the three preparation systems showing statistically significant differences with respect to the other two instruments. This may be attributed to the constant taper of file,unique tear drop cross-sectional design with an off-center mass of rotation, so it establishes only one point contact with the root canal dentinal wall while rotating in the canal during biomechanical preparation, thus limited dentin removal.

There have been no studies comparing these three files i.e. OneShape file,StandardMani SilkfileandBlueflexAcerfileforcanal volumechangeusingCBCT. However, onestudy conducted by **SoniAand Oak A (2018)** hascompared thecanaltransportation andcanal centric abilityofOneShapefileandStandardManiSilkfilesystemusing CBCT.They revealed that Mani Silk file has better centric ability, showed less canal transportation and maintained the original canal morphology better than OneShape Niti rotary file.

Since, Standard Mani Silk file respected the canal morphology with minimum change in the canal volume, provided a safe, efficient and economical means to shape canals may be recommended for the biomechanical preparation of tooth. However, before any definite conclusion can be drawn, further clinical evaluation with larger number of samples and more extensive research with a definitive data distribution should be carried out to evaluate the canal volume change with combination of different file systems.

CONCLUSION

Within the limitations of this study, it may be concluded that Blueflex Acerfile showed `higher increase in the root canal volume as compared to OneShape file, while Standard Mani Silk file showed minimum increase in the root canal volume during preparation. Thus, Standard Mani Silk file may be recommended as an effective file, however, before any definite conclusion can be drawn, larger number of samples coupled with longer duration of clinical evaluation should be carried out to evaluate the canal volume change with these file systems i.e. OneShape file, Standard Mani Silk file and Blueflex Acerfile using CBCT.

BIBLIOGRAPHY

1. Agarwal, RS, Agaawal, J, Jain, P & Chandra, A 2015, 'Comparative analysis of canal centering ability of different single file systems using cone beam computed tomography-an in-vitro study', *Journal of clinical and diagnostic research: JCDR*, vol.*9*, no.5, pp. ZC06-ZC10.
2. Aravindhan, K 2023, 'Comparison of the remining dentin thickness in the root after root canal treatment by two different rotary file system -An in Vitro study',*Journal of Clinical Otorhinolaryngology, Head, and Neck Surgery*, vol.27, no.1, pp 5419-5428.
3. Berechet, D, Rad, IA, Berce, CP, Bumbu, BA, Vicas, RM, Berechet, MC & Cimpean, SI 2018, 'A micro-computed tomography study of morphological aspect of root canal instrumentation with ProTaper Next and One Shape New Generation in mandibular molars',*Rom J MorpholEmbryol*, vol.*59*,no.2, pp.499-503.
4. Bhavthankar, A, Ahuja, T, Nanda, Z, Deore, R, Gakhare, RI & Kumar, R 2018, 'A comparative evaluation of root canal transportation and centering ratio associated with hand protaper, rotary protaper and silk rotary files in continuous rotary motion and reciprocating motion using cone beam computed tomography-An in vitro study',*Journal Of Applied Dental and Medical Sciences*, vol.*4*, pp.1-6.
5. Elashiry, MM, Saber, SE&Elashry, SH 2020, 'Comparison of shaping ability of different single-file systems using microcomputed tomography', *European Journal of Dentistry*, vol.*14*, no.01, pp.070-076.
6. Elmoazen, R, Eldin, MSS & Abd Elkhalek, WM 2017, 'Three-Dimensional observation of Age-related change in pulp Volume using CBCT among Egyptians', Mandibular Canines. *age*, vol. 63, no,2, pp.1-5.
7. Elnaghy, AM & Elsaka, SE 2016, 'Shaping ability of ProTaper Gold and ProTaper Universal files by using cone-beam computed tomography',*Indian Journal of Dental Research*, vol.*27*,no.1,pp.37-41.
8. Fayek, MM, Amer, ME & Mohamed, NA 2024, 'Dental age estimation based on pulp chamber/crown volume ratio measured on CBCT images',*Egyptian Dental Journal*, vol.*70*,no.1, pp.243-250.
9. Patel, D, Patel, F, Patel, K, Desai, N, Patel, K & Shah, P 2021, 'Analysis of the cutting efficiency of two different nickel–titanium rotary file systems: An in vitro study',*International Journal of Oral Care and Research*, vol.*9*,no.4, pp.100.
10. Singla, MG, Kumar, H & Singh, N 2021, 'A comparative evaluation of canal transportation, centering ability, and volumetric increase in the curved canals using thermally treated three nickel-titanium rotary files: A cone-beam computed tomography study',*Endodontology*, vol.*33*,no.2,pp.75-80.
11. Sobh, YTM & Ragab, MH 2024, 'Residual dentin thickness of root canal transportation by various metallurgical rotary systems: An in vitro study',*Saudi Endodontic Journal*, vol.*14*,no.1, pp.69-74.

12. Soni,A& Oak, A. 2018, 'Comparison of canal transportation and centric ability of two nickel-titanium rotary systems using cone beam computed tomography: An in vitro study',*Dental Journal of Advance Studies,* vol.*6*,no.2, pp.076-079.
13. Suneetha, MG, Moiz, AA, Sharief, H, Yedla, K, Baig, MM & Al Qomsan, MASA 2020, 'Residual root dentin thickness for three different rotary systems: A comparative cone beam computed tomography: in vitro: study',*Journal of Indian Society of Pedodontics and Preventive Dentistry*, vol.*38*,no.1, pp.48-55.
14. Yilmaz, F, Sonmez, G,Kamburoglu, K, Koc, C, Ocak, MERT & Celik, HH 2019, 'Accuracy of CBCT images in the volumetric assessment of residual root canal filling material: effect of voxel size',*Nigerian journal of clinical practice*,vol. *22*,no.8, pp.1091-1098.
15. Zhao, D, Shen, Y, Peng, B & Haapasalo, M 2014, 'Root canal preparation of mandibular molars with 3 nickel-titanium rotary instruments: a micro–computed tomographic study', *Journal of endodontics*, vol.*40*, no.11, pp.1860-1864.