



Geometric Analysis of Root Canals Prepared by XP-3D Shaper™, TF Adaptive and Protaper Next Using CBCT: An *Ex Vivo* Study

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ABSTRACT

Schilder stated that “root canal systems must be cleaned and shaped: Cleaned of their organic remnants and shaped to receive a three dimensional impervious seal of the entire root canal space.” Canal-shaping is a critical aspect of endodontic treatment because it influences the outcome of the subsequent phases of canal irrigation, obturation and the overall success of the treatment itself. Adequate instrumentation combined with effective irrigation is required to achieve sufficient disinfection during root canal treatment.

Keywords: Root canal; Canal-shaping; Endodontic treatment; Obturation

INTRODUCTION

Schneider also emphasized that the root canal should present a flare shape from apical to coronal, preserving the apical foramen and not altering the original canal curvature. Several methods have been used for evaluating canal shaping like radiographs, tooth sections, plastic blocks, microcomputed tomography etc [1]. Cone Beam Computed Tomography (CBCT) has been specifically designed and found to be a gold standard to produce undistorted three dimensional information of the maxillofacial skeleton, including the teeth and their surrounding tissues with a significantly lower effective radiation dose, faster image acquisition and reconstruction scheme and aids in diagnosis of canal morphology as compared with conventional radiography and medical grade computed tomography [2]. With the use of advanced techniques like CBCT it has become easier to compare the efficacy of instruments during preparation of curved root canals with respect to ability of instruments to maintain original canal curvature, centring ability of the instrument during canal preparation and its ability to preserve dentin thickness.

In the present study CBCT was used to observe root canal in three dimensional planes comparing the centric ability of XP-3D Shaper™ system, TF adaptive and protaper next file system during chemomechanical preparation in mandibular molars [3].

MATERIALS AND METHODS

Thirty freshly extracted mandibular molar human teeth were selected, tissue fragments and calcified debris were removed from teeth by scaling. Teeth were disinfected in 0.1% thymol solution at 9 degree C for 24 hours, rinsed and immersed in saline at 4 degrees. Teeth were decoronated 2 mm above the CEJ embedded into acrylic blocks of uniform dimensions and were scanned preoperatively. Then the samples were divided into three groups (n=10 each).

- XP-3D Shaper system
- TF adaptive file system
- Protaper next

Preparations were made in conjunction with endoprep RC as a lubricant and chelating agent. Irrigation was performed with 10 ml 2.5% NaOCl after each instrument. Root canal preparations were performed using the three systems respectively according to manufacturer's instructions by a single operator. All the samples were subjected to the post-operative CBCT scans for the comparative analysis of the pre and post-operative images [4].

CBCT scanning: 3D image acquisition was performed using the CBCT CS 9300 and all the measurements were performed by a single experienced investigator. The open source software CS 3D on demand was used for 3D multiplanar reconstruction. (The technical outcomes were then compared at 1, 2, 3, 4, 5, 6 and 7

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mm intervals to evaluate the progressive changes in canal shape after using the file systems (area, volume and centric ability were the parameter evaluated).

RESULTS

The results obtained suggested that all three systems used in this study for centric ability showed significant variations. The results were subjected to one way Anova and Turkey's post hoc analysis and mean and the standard deviation, centric ability, cross-

sectional area and volume were measured for each instrument. The results were statistically analysed at 5% level of significance and it was seen that group 1 (XP-3D shaper system) showed superior results as compared to group 2 and 3 in all the variables including area, volume, centric ability. The values are described in Tables 1 and 2 [5].

Table 1: Intergroup comparison based on various groups materials using one way anova.

		N	Mean	SD	95% confidence interval for mean		F value	p value
					Lower Bound	Upper Bound		
Area	1	10	11.84	1.51	10.76	12.92	34.411	0.001**
	2	10	9.18	1.09	8.4	9.96		
	3	10	6.97	1.31	6.04	7.91		
	Total	30	9.33	2.39	8.44	10.22		
Volume	1	10	12.64	1.03	11.91	13.38	52.169	0.001**
	2	10	10.27	0.77	9.72	10.82		
	3	10	8.49	0.92	7.83	9.15		
	Total	30	10.47	1.94	9.74	11.19		

Table 2: Post HOC analysis on various groups using Tukeys highest significant difference.

	Comparison between the sub groups	Mean difference	P value
Area	XP-3D vs. TF adaptive	2.66300*	0.001**
	XP-3D vs. protaper next	4.86900*	0.001**
	TF adaptive vs. protaper next	2.20600*	0.002*
Volume	XP-3D vs. TF adaptive	2.37800*	0.001**
	XP-3D vs. protaper next	4.15400*	0.001**
	TF adaptive vs. protaper next	1.77600*	0.001**

DISCUSSION

Since the introduction of NiTi a number of different files have been developed. Ideally the instrument should always conform to the original shape of the canal while root canal preparation. Many studies demonstrated that the NiTi instruments remained better centred in the canal compared to stainless steel files. However transportation of canal can still occur with these

instruments [6]. Over the years many instruments have been developed and numerous studies have been done to compare several new systems for their ability to avoid deviating the preparation from its original axis and thereby reducing endodontic mishaps. Canal transportation is one of the most common mishaps during instrumentation of the root canals. When transportation occurs it has two components: Direction (Dentin removal in single direction off the main tooth axis) and

deviation *i.e.*, undesirable departure from the original canal path as a function of file action. If the canal preparation in the apical-third of the root is not centered, it might lead to blockages, perforations and ledges and other procedural errors [7]. The ability to enlarge the canal without canal deviation is a primary objective in endodontics. So it is important to compare the efficacy of instruments during preparation of curved root canals with respect to ability of instruments to maintain original canal curvature. In the past serial sectioning, radiographic methods, stereomicroscopic assessment, clinical and scanning electron microscopy have been used to determine remaining dentin thickness and centric ability. These above mentioned methods were invasive and the accurate positioning of specimens is difficult. Radiography provides two dimensional images of three dimensional objects. CBCT imaging modality is an effective technique to evaluate and measure dentin thickness, canal curvature, apical transportation and canal centering as it provides images in orthogonal planes as well as in oblique planes. Other advantages of this method are that there is no destruction of the sample, shorter examination time and reduced image distortion. In the present study cone beam computed tomographic images of the samples were obtained pre operatively and post operatively [8].

Very few researches have been done on the XP-3D Shaper™ files. In the present *ex-vivo* study group 1 (XP-3D Shaper™ brasseler USA system) showed superior results as compared to group 2 and 3 in all the variables including area, volume and centric ability. These results of group 1 can be attributed to the following properties of the systems firstly XP-3D Shaper™ system size and expansion capacity: As it rotates, the instrument's orbit expands and contracts to abrade the broad and narrow aspects of the canal equally. Secondly maxwire technology: Adapts to the canal's natural anatomy by expanding and transforms to a robust, predefined serpentine shape at body temperature, it is super elastic, extremely flexible. Thirdly booster tip TM and adaptive core technology: The patented booster tip design helps guide the serpentine XP-3D Shaper™ around curvatures and keeps it centered in the canal, the adaptive core allows the smaller central core of the files to move freely and adapt to the canals natural morphology [9]. The XP-3D shaper™ design characteristics drastically limit the amount of torque and stress applied to both the instrument and the canal. This results in reduced instrument separation and dentinal micro-cracks. The group 2 TF adaptive file system group showed better results than protaper next system (group 3) which might be due to the fact rotary when wanted and reciprocation when needed "adaptive" employs a patented unique motion technology, which automatically adapts to instrumentation stress. When the TF adaptive instrument is not or very lightly stressed in the canal, the movement can be described as a continuous rotation, allowing better cutting efficiency and removal of debris-since cross-sectional and flute design are meant to perform at their best in a clockwise motion. On the contrary, while negotiating the canal, due to increased instrumentation stress and metal fatigue, the motion of the TF adaptive instrument changes into a reciprocation mode. Protaper next, is an M wire alloy despite its many advantages it

also has shown few disadvantages which might be responsible for the results of the present study, they are non-anatomic shaping, an eccentric NiTi file and can cut slightly outside of its central axis of rotation, all cutting edges are not engaged simultaneously and also this system requires the use of multiple NiTi files.

Based on the results of present study it was evident that XP-3D Shaper™ system preserved more dentin during the preparation of the root canals. Future studies may explore the potential added value of this newer system in the root canal preparation [10].

CONCLUSION

Within the limitations of this *ex-vivo* study, it was concluded that XP-3D Shaper™ system has optimal centric ability that was statistically significant and better as compared to the TF adaptive and protaper next system. The materials being newer are advanced, long term clinical studies are required to determine the success rate of the XP-3D Shaper™ system in effectively cleaning and shaping the root canal system.

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