

Root Canal Preparation using Hyflex EDM/CM VS Revo S in Curved Root Canals, a Comparative in-vitro Study

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Abstract

Shaping ability, fracture resistance and speed are 3 critical prerequisites for NiTi rotary instruments. The purpose of this study was to compare root canal preparation in curved canals of molar teeth with the NiTi rotary Hyflex EDM/CM and Revo S systems in terms of canal shape, instrument separation and time of preparation.

Mesiobuccal canals of 40 molar teeth with apical angles of curvature between 25 and 35 degrees were enlarged, shaped and cleaned with a torque controlled Endo IT motor (NSK-Japan): 20 canals with Hyflex EDM/CM and 20 other canals with the Revo S. Each instrument in both systems was used to prepare just 4 root canals. Standardized periapical radiographs were taken before and after preparation in order to determine canal transportation in each group. The time of preparation for each root canal was also recorded.

Hyflex EDM/CM system gave a statistically less canal transportation and as a result, was preferable for preserving the original shape of the root canal ($P=0.024$). There was no significant statistical difference between the 2 systems in term of the preparation time. ($P=0.09$).

Based on the results of this study, the Hyflex EDM/CM NiTi rotary system maintains the original shape of curved root canals better than the Revo S with less possibility of instrument separation.

Experimental article (J Int Dent Med Res 2020; 13(1): 97-100)

Keywords: Hyflex EDM/CM, Nickel –Titanium, instruments, Revo S, shaping ability.

Received date: 28 May 2019

Accept date: 15 November 2019

Introduction

Transportation is one of the RCT mishaps that changes canal terminus to a new position that may complicate the root canal treatment outcomes. Canal transportation that results from the change in original shape of the root canal may even lead to ledge formation and also zipping perforation.^{1,2} Today the evolution of new engine driven nickel-titanium rotary instruments has highly reduced the chance of canal transportation and other RCT mishaps in comparison with old carbon steel or stainless steel hand intra canal instruments especially in calcified and curved root canals.^{3,4}

Hyflex EDM / CM (Coltene-Swiss) and the Revo S (Micromega-France) are 2 recently introduced NiTi rotary systems categorized in the

fifth generation of these systems that offer fast and safe root canal preparation along with minimum changes to the original shape of the root canals. The manufacturers claim that the efficiency of canal shaping in these systems has highly been improved by offsetting the center of rotation. These center of rotation offset designed instruments produce a mechanical wave of motion that distributes along the full length of the NiTi file, improves cutting and enhances debris removal in comparison to the previous generation instruments. Furthermore, this offset design reduces the screwing effect of the instruments that causes instrument separation.^{5,6} The aim of this study was to compare the shaping ability, rate of instrument separation and the time of preparation between these two systems in curved root canals of extracted human molar teeth.

Materials and methods

A total of 40 extracted human mandibular and maxillary molar teeth having at least one curved and intact mesiobuccal root canal were

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used in this in-vitro study. The teeth had been extracted because of inability of the patients to afford treating them, periodontal diseases or prosthetic treatment planings and were kept in a bottle that contained 2.5% NaClO solution (Shimin-Tehran). Access cavities were made using diamond burs, and the canals assessed for apical patency using an ISO 10 file (Maillefer-Swiss). Only teeth with intact root apices and a root canal width of an ISO 15 file(Maillefer-Swiss) in the apical third were selected. The teeth were mounted on acrylic resin boxes and radiographed with an ISO 15 K file in the curved mandibular or maxillary mesiobuccal canal. Similar exposure settings (70 kV; 7 mA,0.12sec) were applied for all teeth.⁷⁻¹⁰The degree and radius of root canal curvature were determined, using the provided radiographs along with the Schneider and the Pruette analysis methods.^{11,12}

Only teeth whose angles of curvature ranged between 25 and 35 degrees and whose radii of curvature ranged between four and nine were used in the study. The selected samples were then divided randomly into 2 experimental groups of 20 each, each of which included 10 mandibular and maxillary molars per sub-group.

In the first group, the Hyflex EDM/CM NiTi rotary system (Coltene-Swiss) was used to instrument the selected curved canal, according to the manufacturer's instructions. The instrumentation sequence in Hyflex EDM/CM System for curved root canals are: First- An optional access opening file which is used at coronal 1/3. Second- A no 10/05 Glide path used at middle 1/3.Third-2 Shaping files; a no (20/05 HyFlex CM and a no25 (HyFlex EDM file) used to prepare the apical 1/3.copious irrigation was done after each instrument change, with 2.5% NaOCl and 17% EDTA solutions. Each individual instrument was used to prepare just four root canals.^{3-5,13,14}In the second group, the Revo- S NiTi rotary system(MicroMega-France) was used to prepare the selected curved root canals.

The Revo S NiTi rotary system applies 3 instruments to achieve the enlarging, shaping and cleaning of the root canal system. The speed of the snake like up and down and rotation of the engine driven nickel-titanium instrument in this system is:250-400 rpm. The sequence of using the instruments in this system is:

No 25 /06 L= 21 mm; at 2/3 working length

No 25 /04 L= 21,25 or 29 mm; at working length

No 25 /06 L= 21 ,25 or 29mm; at working length⁴.

In each sample, the time required for canal preparation was recorded. Means and standard deviations were calculated separately for mandibular and maxillary molars in each of the two experimental groups and differences in preparation time assessed using analysis of variance.

Post treatment radiographs were taken, with the final instrument placed inside the canal, and used to determine the degree of curvature after root canal preparation. As before, means and standard deviations were calculated separately for mandibular and maxillary molars in each of the two under study groups and differences between groups assessed using analysis of variance and Tukey-Kramer multiple comparisons post-hoc tests.

Results

The change in the degree of canal curvature in the mesiobuccal root canals of the maxillary molar teeth prepared by Hyflex EDM/CM , was significantly less than the mesiobuccal canals of the maxillary molar teeth prepared by the Revo S NiTi rotary system.(P= 0.020). This change, in the mandibular molar teeth between 2 systems was not statistically significant. (P=0.3). Over all Hyflex EDM/CM group gave less canal transportation than the Revo S group. (P=0.024).

System	Location	NO	Angle before preparation (Mean/sd)	Angle post preparation (Mean/sd)	Diff. Angle (Mean/sd)
Hyflex	Maxillary molars	10	33.70(2.31)	31.9(2.23)	1.8(1.39)
	Mandibular molars	10	31.10(3.14)	28.6(3.1)	2.5(1.51)
Revo-s	Maxillary molars	10	32.90(2.07)	29.2(3.32)	3.7(1.49)
	Mandibular molars	10	32.00(2.74)	29.3(1.94)	2.70(1.06)

Table 1. The comparison of the difference in canal curvature between Hyflex/ EDM/CM and the Revo S NiTi rotary systems in maxillary and mandibular molar teeth. Group Statistics.

Rotary systems	N	Mean	Std. Deviation	P value
Hyflex	20	2.1500	1.46089	0.024
Revos	20	3.2000	1.36111	

Table2. The overall comparison of the difference in canal curvature between Hyflex/ EDM/CM and The Revo S NiTi rotary systems.

There was no significant statistical difference between 2 systems in term of the preparation time. (P=0.09). Just one Revo S instrument separated in this study. The results of this study are summarized in tables:1-5.

System	Location	Number	Time(mean/sd)
Hyflex	Maxillary molars	10	5.21(0.12)
	Mandibular molars	10	5.24(0.05)
Revo-s	Maxillary molars	10	5.12(0.12)
	Mandibular molars	10	5.19(0.11)

Table 3. The comparison of the time of preparation between Hyflex EDM/CM and Revo S NiTi rotary systems.

Rotary System	N	Mean	Std. Deviation	P value	
Time min	hyflex	20	5.2272	.09075	0.09
	Revos	20	5.1608	.11588	

Table 4. Over all comparison of the time of preparation between Hyflex EDM/CM and the Revo S.

System	Location	Number	Fracture
Hyflex EDM/CM	Maxillary molars	10	0
	Mandibular molars	10	0
Revo-s	Maxillary molars	10	0
	Mandibular molars	10	1

Table 5. The comparison of the instrument separation rate between Hyflex EDM/CM and Revo S.

Discussion

Root canal morphology can be changed after root canal preparation depending on the technique used.¹⁵ This study was designed to compare the shaping ability, speed of enlarging, shaping and cleaning and also separation rate of Hyflex EDM/CM and the Revo S, both categorized in the fifth generation of NiTi rotary systems. The study was performed on 40 maxillary and mandibular molar teeth, having at least one curved mesiobuccal canal. The degree of curvature and also the width of the selected mesiobuccal canals had been tried to be the same and all root canals were prepared by one operator. The results of this study showed that the use of Hyflex EDM/CM results in significantly less canal transportation in the curved

mesiobuccal root canals of the molar teeth, especially in the superior arch. There was no significant difference in the preparation time, between 2 systems and by using each individual instrument to prepare 4 root canals, just one instrument separated in the Revo s group.

This is the first study which compares the Hyflex EDM/CM and the Revo S in terms of shaping ability, preparation time and instrument separation. So there isn't any study in the literature to compare the results of current research with that. Hyflex EDM is a new NiTi rotary system that assists from the Electrical Discharge Machining technology to produce a single No25 instrument that cleans and shapes the straight root canals using just one single instrument. In curved root canals the number of instruments, depends on the degree of the root canal curvature. In severely curved root canals (> 35) using the Hyflex CM and in the moderate curved (<35) the Hyflex EDM/CM has been recommended by the manufacturer.^{3,5,16,17}

Burklein et al. in a study in 2014 evaluated and compared the shaping ability, preparation time and the rate of instrument separation between 3 NiTi Rotary systems; Hyflex CM, Revo S and the M two. According to their findings during preparation, none of the files separated. Mtwo and Hyflex CM maintained the original canal curvature significantly better than the Revo-S. Instrumentation with Mtwo and Hyflex CM was significantly faster than the Revo-S. Moreover no significant differences were obtained between Mtwo and Hyflex CM in term of the preparation time.

The use of Revo-S instruments required more time to prepare the curved canals and resulted in more pronounced canal straightening compared with Mtwo and Hyflex CM. Regarding the shaping ability of the Revo S the results of our study is consistent with the Burklein and the colleagues study. In term of the speed of preparation, the results of current study are not in agreement with their study; the Hyflex CM, using even more number of instruments than the Hyflex EDM/CM has been reported to prepare the root canals significantly faster than the RevoS. We didn,t find any significant difference in term of the preparation time between 2 systems. Since none of the Hyflex files separated in our study, Hyflex files seem to have more resistance to separation in comparison with the Revo S NiTi rotary instruments.¹⁶

Lacono et al in a SEM (Scanning Electron Microscopy) study in 2016 reported that the typical irregular surface of Hyflex EDM remains unaffected after multiple uses and has a high wear resistance. They came to this result that the new process of electrical discharge machining has a positive impact on improving the fatigue resistance of Hyflex EDM instruments in comparison with the Hyflex CM category.¹⁷

Simpsy et al in another study in 2016 which compared the shaping ability of 3 Niti rotary systems; Protaper, Wave one (reciprocating) and the Hyflex CM reported that Hyflex CM caused the least amount of transportation among the groups. Between 2 other systems under study, the Wave one (reciprocating) caused less difference in the degree of the root canal curvature than the Protaper sub group. They concluded that in preparing moderate to severe curved root canals using the Hyflex CM and the wave one is preferable to the protaper.¹⁸

X Ray diffraction analysis (XRD) and differential scanning calorimetry (DSC) on new and used HyFlex EDM instruments has revealed peculiar structural properties, such as increased phase transformation temperatures and hardness leading to enhanced mechanical behavior.¹⁹

Conclusions

Based on the results of this study the Hyflex EDM/CM is recommended for a thorough, fast and safe cleaning and shaping of the curved root canal systems.

Acknowledgements

The authors would like to thank the deputy of research of Kerman university of medical sciences for providing financial support to do this study as the grant no:96000206 with the Ethic approval Code: IR.KMU.REC.1396.1285.

The Authors, also would like to thank Dr. Maryam Rad for helping to do data analysis for this research.

Special thanks is dedicated to Dr. Ali Abasi Sardari for hard work to achieve his Thesis.

Declaration of Interest

Nothing to declare.

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