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Evaluation of Canal Centering Ability of REVO-S and Hyflex-EDM Using Cone Beam Computed Tomography: An In Vitro Study

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Abstract

Background: The ability of rotary instruments to remain in center is very important criteria for the preparation of root canal and for the success of the root canal treatment. Assessment of the clinical performance of the centering ability of the file of newly introduced file system is important to determine.

Aim: To compare the canal transportation and centering ability of different rotary file system using Cone Beam Computed Tomography in curved canals after instrumentation with Hyflex-EDM and Revo-S The time taken is also determined.

Methods: A total of 40 sound human maxillary molars with angle of curvature ranging 20-35° were divided into 2 groups of 20 samples each collected. Coronal access will be achieved patency checked with size 10k file . Mesiobuccal canals of maxillary molar are taken for instrumentation. Hyflex EDM [Group I] and Revo-S [Group II] Pre & Post instrumentation 3 dimensional CBCT images were obtained from root cross divison at 3mm, 6mm & 8mm from the apex. Canals were shaped with file using a pecking motion till working lengthlubricating is used. Pre & post instrumentation scans by measuring length tool. Canal transportation & Canal centering ratio at each level is assessed. The evaluation is done with one way ANOVA with Tukeys honestly significant test.

Result: It was observed that there were no differences in magnitude of transportation between the rotary instruments (p>0.5) at both 6mm and 8mm from the apex. At 3mm from the apex Hyflex –EDM Group I showed significantly less mean canal transportation and higher centric ability (0.05±0.44 and 3.73±5.73) as compared to Revo-S Group II (0.075±0.43 and 0.611±0.99).

Introduction

Biomechanical preparation of root canals plays a very important role for the success of endodontically treated teeth. During root canal instrumentation, it is important to develop a continuously tapered form and to maintain the original shape and position of the apical foramen. The ability to maintain the instrument centered is essential to provide correct enlargement, without excessive weakening of the root structure The various mishaps like zips, elbows, perforations or formation of danger zone, apical transportation and ledges may occur, due to the root canal curvature. The dentin plays an important role in the strength of the root. The way the rotary file works, their cutting edges and their ability to be in centre plays a very important role in cutting the minimal of the dentin and determining the shaping the root canal.

The development of Ni-Ti instruments overcomes so many problems created by the K-files. With their property of super flexibility, it leads to the proper cleaning & shaping of the complex root canal system. It reduces forces on the walls, enhanced centric ability, and led to less iatrogenic errors. This super elastic nature of Ni-Ti alloy is due to its ability of transformation between the austenitic and martensitic phases. They regain its original shape (austenite) after the application of stress or heat (martensite) is a characteristic called the “shape memory effect”.

To maintain the original canal curvature is a key element which avoids the formation of ledges in the root canal wall, avoids the elbow formation which occur coronal to the ellipitical shaped apical seal. If the canal curvature is not maintained the biomechanical preparation when done leads to removal of dentin in the larger amount.

So many files have introduced into the market, the ability of rotary files to be in center depends on their instruments design ,their cross section, their tip & taper and also with what alloys is used for manufacturing instruments. Two commonly used materials are Stainless Steel materials & Nickel Titanium alloys.

The new approach in the field of files the nickel titanium files, preserve the root canal anatomy, very effective in biomechanical preparation cleaning and shaping, with minimum procedural errors in the curved canals. As the study goes on Ni-Ti instrument design & their manufacturing process goes on improving, so that over reliability on them goes on increasing. They are much more effective and safe to use. They cut the minimal dentin and also decrease the torsional load. As more the aggressive cutting leads to canal transportation. The more the dentin thickness present in the endodontic tooth, the more structure durability of tooth.

Centric ability is the ability of the instrument to remain in central position within the canal. The ability to enlarge the canal to avoid any canal deviation leads to minimum chances of apical transportation or instrument separation. So ability of instruments to be in center or to maintain the original canal curvature is very important. Cimis et al stated that 46% of the curved canals have varying degrees of apical transportation subsequent to instrumentation.

The Cross –Section, Tip & Taper of file plays very important role in maintaining the canal centering ability. Tip Three types are there Pyramidal, Conical, Biconical. Diameter is less in Biconical design as compared to pyramidal and conical design so have better centering ability.

Hyflex–EDM (Coltene) are produced using an innovative manufacturing process called Electric discharge machining which results in a file that is extremely flexible & high fracture resistant.

Revo-S asymmetrical cross section has three cutting edges located on three different radius R1 R2 & R3, smaller section allows a better ability to negotiate curves.

To get the three dimensional image of the tooth, is taken by Cone Beam Computed Tomography Imaging as shaping ability evaluation without the loss of specimen. It is a non -invasive technology.

This study is done to access the canal transportation and ability of Hyflex-EDM and Revo S rotary files to be in center that is its canal centering ability to have the maximum dentin thickness.

Methodology

The present in vitro study was conducted in the Department of Conservative Dentistry & Endodontics, Babu Banarsi Das College of Dental Sciences; Lucknow with imaging facility of Cone Beam Computed Tomography availed at Raydent with the iCAT vision Software Anatomage at Lucknow.

Freshly forty extracted human Maxillary First molar extracted due to periodontal reasons, handled as per safety guidelines of ADA. Non carious, sound, Permanent maxillary molar with an angle of curvature ranging from 20˚- 35˚ are taken assessed according to Schneider's technique. Teeth with curvature greater than 35˚, any crack or caries, any developmental anamoly, any restoration, root fracture, root resorption, calcification are excluded from the study sample based on the buccolingual and mesiodistal radiographic images.

Coronal access was done using endo access bur & canal patency is checked with 10k file. All teeth were decoronated to a length of 8 mm from root apex near furcation area using a diamond disk & were randomly divided into 2 groups of 20 teeth.

- Group I- 20 Hyflex EDM
- Group II- 20 Revo-S

Orthodontic wire is used on the sheet for proper scan orientation. The proper standardization of the specimens for the tomography images before and after root canal instrumentation is maintained by mounting horizontally fitted with its plane parallel to wax sheet. Pre & Post instrumentation 3 dimensional CBCT images were obtained from root cross division at 3mm, 6mm & 8mm from the apex. The mesiobuccal canals were taken up for instrumentation. Canals were shaped using a pecking motion till working length. Canal preparation done using lubricant & after each file 1ml of 3% NaOCl canal irrigant is used. The flutes of the instrument were cleaned after 3 in & out movements [pecks] using NaOCl soaked sponge.

Assessment of Root canal Preparation is done. The minimum distance from mesial and distal edge of the mesiobuccal canal to the periphery of the root will be measured on the reconstructed cross sectional images of the pre & post instrumentation scans by measuring length tool.

[a].Degree of transportation was calculated according to the formula given by Gambill

[A1-A2] - [B1-B2]

A1is the minimum distance from the mesial edge of the root to the mesial edge of the un instrumented canal.

A2 is the minimum distance from the mesial edge of the root to the mesial edge of the instrumented canal.

B1is the minimum distance from the distal edge of the root to the distal edge of the uninstrumented canal

B2 is the minimum distance from the distal edge of the root to the distal edge of the root to the distal edge of the instrumented canal.

[b].Canal centering ratio at each level according to the following ratio:

[A1-A2]/ B1-B2] or [B1-B2]/[A1-A2]

Formula chosen in such a way so that lowest results obtained through the difference should always be the numerator. Perfect centralisation indicted by one.

Observation and Results

Data are summarised as Mean ±SE (Standard error of mean).Groups were compared by One –way analysis of variance (ANOVA) and significance of main difference between (inter) the groups was done by Tukey's honestly significant difference (Tukey's HSD) post hoc test was applied for intergroup comparison of canal transportation, canal centering ability.

P< 0.05 was considered as the statistically significant level. Analysis was performed on Data Analysis tool of Excel and SPSS software.

Centering Ability Evaluation

At coronal, middle and apical level both at mesial and distal the Hyflex –EDM was found statistically significantly better (p<0.05) as compared to Revo-S. At 3mm from the apex Hyflex –EDM Group I showed significantly less mean canal transportation and higher centric ability (0.05±0.44 and 3.73±5.73) as compared to Revo-S Group II (0.075±0.43 and statistically significant.

Table 1: Mean of Degree of canal transportation

Groups	3mm	6mm	8mm
I	-0.050±0.440	-0.085±0.666	-0.006±0.328
II	-0.075±0.433	-0.137±0.378	-0.127±0.435

Table 2: Mean centering ratio of three different files at 3mm, 6mm and 8mm

Groups	3mm	6mm	8mm
I	3.731±5.273	1.851±3.812	1.552±1.489
II	0.611±0.992	0.907±1.488	1.011±1.243

Discussion

In present study, forty human first maxillary molars were selected because this sample size was found to be statistically significant. The mesiobuccal root of first maxillary molar were selected for study because mesiobuccal root mostly shows the accentuated curvature of 20-35˚ and the chances of zipping, elbow, transportation, increases if any deviation from eccentric path occurs in curved canal[1]. The teeth were decoronated and mesiobuccal root was sectioned. Cone beam computed tomography facility was used to take preoperative and after instrumentation (postoperative) scan. The canal centering ratio was calculated by Gambill formula.[15]

In this study, two file systems Hyflex –EDM and Revo –S were used.

The Hyflex-EDM system files were used in this study as it is a newer and highly flexible file system, which resist fracture and instrumentation separation as claimed by manufacturer. It can be used as a single file system.

Revo S file system developed by Micro Mega, has asymmetrical cross section which provides less stress on the instrument. File has an inactive tip three cutting edges and three radiuses that allows more flexibility and offers a better ability to negotiate curved canals.

The objective of the present in vitro study was to evaluate and compare the canal transportation centering ability of the different rotary file system after instrumentation. In the curved canal it is difficult to shape the root canal while maintaining its canal curvature. Instrumentation in a curved canal chances of cutting the outer dentinal wall increases and transportation or perforation incidence increases if operator looses the centering path.[1] Deviation from the original canal curvature due to canal instrumentation can leads to excessive and inappropriate

dentin removal causes straightening of canal, creation of ledge or any procedural error in the dentinal wall[1].

With the development of Ni-Ti instruments, a new era has developed for proper cleaning and shaping of canals. Many files came into existence which helped in proper shaping and cleaning of the curved root canals. In the curved canals, the hand endodontic instruments were precurved so that the stress acting on the instrument can be negotiated during the curvature[8]. But the force require to bend the instrument was same and the instrument exerted force on the outer curvature of the canal which led to more cutting resulting in eccentricity[11] to avoid this error, rotary file systems came into existence that reduced the operating time and failures related to instrumentation[7].

Centric ability is a variable which depend upon the following factors of the file such as alloy and technique which is used in manufacturing process, flexibility, the cross-section, Taper and Tip of the instrument used[14].

In the present study the results were compared for the transportation at each level 3mm, 6mm and 8mm from the apex. These levels were chosen as standardized levels as the maximum ramifications were found[14].

In the present study, Group I(HyflexEDM) showed higher canal centering ability then seen in Group II (Revo-S).

The superior centering ability of Hyflex-EDM files can be due to its manufacturing process. This file is produced by Electric discharge machining that uses spark erosion to modify the surface properties. Moreover, it possesses different cross section at different levels which leads to less canal transportation and controlled material memory. It has triangular cross section at top, trapezoidal cross section in middle and quadratic cross section at tip which progressively changes three to two cutting edge, so has better centric ability. The taper of this file also restricts its eccentricity. The result of this in vitro study is in accordance with the results of the study done by Tambeet al.

The results obtained in the present study were similar to results exhibited in the study conducted by Deepak B S et al.who found that Hyflex- EDM showed the better centering ability.

Sankhe D devaluated the effect of Hyflex EDM on root canal preparation using stereomicroscope evaluation. It was shown that Hyflex EDM showed lowest percentage of canal transportation with minimum time taken period. Thus, HyFlex EDM was found more efficient in root canal preparation than that of Protaper Universal thereby preventing dentinal defects or microcracks leading to root fractures..

In the present study, Revo-S (Group II) exhibited the least centeric ability which can be due to its file design bearing a constant taper and asymmetrical cross section. Moreover, the file axis has three cutting edges located on three different radii. Thus, removing more of dentin on outer aspect of the canal.

In the present study, the time taken in root canal preparation of Hyflex-EDM was less as compared to Revo S file groups. It was because of great flexibility, good fracture resistance and better cutting efficiency of hyflex EDM. This reduced any procedural error too[8] In the present study the Hyflex-EDM preserved the dentine thickness with proper shaping of the root canals as compared to Revo-S. This may be due to its variable cross section and controlled memory property. Because of superior flexibility, Hyflex EDM file maintains the original canal anatomy.

In the present study Cone Beam Computed Tomography was used. Pre and Post scan were taken at different cross section which provided the three dimensional observation. This is most accurate method for accessing the centric ability of rotary system at a low radiation dose with higher

resolutions[11]. The principle of Cone beam computed tomography depends on image acquisition where an X-ray source and image receptor reciprocate around patient 180-360 degrees to acquire 180-1024, 2D cephalometric images. Cone Beam Computed Tomography does not cause the distortion and results are reproducible[11-25].

To summarize, in the present study Hyflex –EDM Group I showed significantly less mean canal transportation and higher centric ability (0.05±0.44 and 3.73±5.73) as compared to Revo-S Group II (0.075±0.43 and 0.611±0.99)

The time taken for Hyflex-EDM Group I was less (20.40±2.08) than Revo-S Group II (61.45±2.68) .

Conclusion

Within the parameters of the present study, it can be concluded that Hyflex-EDM showed significantly more centric ability Revo-S in a canal with 25-30 degree curvature. Hyflex-EDM showed less canal transportation and took less time to prepare the canal followed by Revo-S.

Dentin thickness was maximum preserved when Hyflex-EDM files when tested along with and Revo-S.

It can be concluded from the results of this study that it is advisable to use this recently introduced Hyflex-EDM file system in a curved canal in order to avoid any procedural error maintaining the original curvature of the canal in very short period of time.

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