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"PREPARATION OF CURVED ROOT CANALS WITH DIFFERENT HYBRID ROTARY INSTRUMENTS: A COMPARATIVE STUDY"

Dental Science

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ABSTRACT

Introduction: Hybrid rotary instrumentation, involving Tri Auto Mini with Root Zx Mini, in combination with newer rotary systems, are claimed to provide accurate and efficient length determination along with a centred preparation, retaining the original canal curvature.
Methodology: 90 mandibular first molars were selected and prepared on the bases of predetermined criteria with Hyflex CM, Twisted files and Revo S system. Root canal preparation time, working length control, instrument failure and centricity of the prepared canals were evaluated. Collected data was statistically analysed with Shapiro-Wilk test, Kruskal-Wallis, One-way ANOVA and Tukey post hoc test.
Result: Hybrid instrumentation successfully maintained the working length in all the samples. Hyflex CM and Twisted Files systems retained the original canal curvature. Preparation was fastest with Twisted files followed by Hyflex CM and Revo S, respectively. Hyflex CM displayed the maximum defects.

KEYWORDS

Hybrid instrumentation, Hyflex CM, Revo S, Twisted files

Introduction:

The success of endodontic treatment is determined by complete elimination of pathogens during biomechanical preparation followed by hermetic obturation of root canal system. Use of rotary instruments is more efficient and feasible for biomechanical preparation. Root canal instrumentation till the estimated working length, while maintaining original canal morphology are the most crucial criteria during biomechanical preparation. Hybrid rotary instrumentation such as combination of electronic apex locators with rotary endomoter is helpful towards this end. [1]

Tri Auto Mini with Root ZX mini, (J. Morita, Tokyo, Japan) in combination have advanced features, like integration of an apex locator with an electric motor for biomechanical preparation. This combination is based on Tri Auto ZX device, which possess reliable efficacy and provide calibration on various parameters, in the form of torque control, apical auto reverse functionality and apical slow down. [2]

Recently introduced rotary Ni-Ti systems such as Hyflex CM (Coltene/Whaledent, Switzerland), Twisted files (SybronEndo, USA) and Revo S ((Micro Mega, France), result in a more centered preparation retaining the original canal curvature. Each of the file system claim to possess superior properties than the other resulting in more centred preparation and reduced possibility of fracture. [3,4,5]

This in vitro experimental study aimed to evaluate the precision control of hybrid rotary system instrumentation, consisting of Root ZX Mini along with Tri Auto Mini device, comparing the centric ability, preparation time and instrument failure of different rotary instruments within curved root canals.

Methodology:

Freshly extracted mandibular molars were collected and washed under running water, cleaned and disinfected. They were individually evaluated both clinically and radiographically.

90 teeth were selected based on the following inclusion and exclusion criteria. Inclusion criteria were intact teeth with completely formed mesiobuccal root of maxillary first molars with curvature between 25° and 35°. Exclusion criteria were teeth with carious lesions, or restoration, or endodontically treated teeth, roots with calcification, teeth with relatively straight root, fracture, craze lines and roots with resorption.

These samples were randomly divided into three groups consisting of 30 samples each. In each sample access cavity was prepared and patency was established with a size 10 K-file. (Mani, Japan) The coronal portion was initially flared with Gates Glidden drills.

In each group, set of 5 samples was embedded into freshly mixed alginate, poured in a plastic box with aided metal clip. Clip was attached with the apex locator to simulate teeth and supporting tissue. Biomechenical preparation was carried out in each group by rotary hybrid instrumentation with the respective file systems, according to the manufactures instructions. During the preparation advance function like apical stop and apical reverse down were kept on. Each instrument was used to prepare maximum of 5 canals.

In group A, preparation was carried out with Hyflex CM files. Instrumentation was carried out in a gentle in-and-out motion at 500 rpm speed and 2.5 Ncm torque. Single-length technique was used till 0.06 taper size 25 instrument.

In group B, Twisted files were used at 500 rpm speed with 2 Ncm torque till full working length. Final apical preparation was carried out till no. 25 instrument with 0.06 taper.

In group C, Revo S files were used in crown down approach with 350

rpm speed and 2.5 Ncm torque. Gentle in and out motion with passive instrumentation was done till 0.06 taper size 25 instrument.

After each instrument use, irrigation with 2 mL of 2.5 % NaOCl solution was performed. Final irrigation was done with 5 mL of NaoCl followed by 1 ml saline solution using a Side vented needle.

All the samples were prepared by a single operator. Post preparation digital radiographs were taken. Digital image were compared in coral draw software. Root canal straightening or curvature was analysed by Schneider's method by drawing angle digitally. Straight parallel line (AC) drawn from the canal orifice along with the file. A second straight line (BC) is drawn from the apex until it meets the first line (AC) at a point (C) which represents the curvature angle. [Fig.1] Images were superimposed and analysed. Total active instrumentation time was measured from staring of first instrumentation till final instrument used. Working length control was analysed as instrumentation 0.5 short from apical foramen with anatomical changes. Number of fractured or permanently deformed instruments were noted and evaluated.
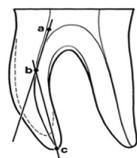

Figure 1 - Curvature assessment

Statistical analysis:
Shapiro-Wilk test showed that degree of straightening of curved canals after canal preparation did not follow normal distribution, hence non-parametric tests Kruskal-Wallis and Mann-Whitney U tests were applied for comparison. As preparation time data was on normal curve, parametric tests One-way ANOVA followed by Tukey post hoc tests were applied for further data analysis. The number of defects in files (categorical data) were statistically analyzed by applying Pearson' Chi-square test. P value <0.05 was considered statistically significant. Data analyses were performed using version 21.0 of the Statistical Package for Social Sciences (IBM Corporation, Armonk, New York, USA).

Results:
With the combined hybrid rotary instrumentation, apical limit was not crossed in any of the samples, irrespective of the file system used. Working length was maintained in all samples without distortion of anatomy of apical foramen.

The degree of straightening of curved canals in Revo-S was significantly higher than Hyflex CM and Twisted Files systems. There was no significant difference between Hyflex CM and Twisted Files systems for degree of straightening of curved canals. On evaluation of the pre and post procedural radiographs, degree of straightening with Hyflex Cm, Twisted files and Revo S was found to be 1.10 ± 1.16, 1.17 ± 1.15 and 4.17 ± 1.26 respectively. [Table 1] [Graph 1]

The preparation time taken by Hyflex CM system ranged from 198.00-285.00 having a mean range of 238.20 ± 18.43 seconds, for Twisted files it ranged from 191.00-279.00 with mean of 229.77 ± 18.56 seconds and for Revo S it ranged from 249.00-326.00 with a mean of 281.57 ± 14.41 seconds. The preparation time with Revo-S was significantly higher than Hyflex CM and Twisted Files systems. There was no significant difference between Hyflex CM and Twisted Files systems for preparation time. [Table 2] [Graph 2]

During the preparation none of the files fractured. All three file systems developed defects between 20.00% to 30.00%. Hyflex CM developed deformation in 10 samples as unwinding of flutes. Twisted file developed defects in 7 files including tip deformation and flute wear off while Revo S showed deformation in 7 files as minor structural changes. [Table 3] [Graph 3]

Discussion:
Preparation of the curved canals is fraught with difficulties. The biggest challenge is, maintaining the curvature and length. The working length has been classically established and maintained with the help of a radiograph and later with apex locators. [6] Dentine

removal from curved canals after conventional instrumentation leads to straightening and affect the outcome. [8] The hybrid instrumentation available in the recent past makes these two modalities superfluous. [9]

Newer NiTi systems claim to be superior in preparing curved canals, while maintaining canal curvature. [4] Moreover hybrid instrumentation is being vehemently advocated. It is claimed to be efficient and is more precise with less chances of error. [2] This study was an attempt to evaluate and compare the preparation capability of hybrid instrumentation - combination of the Root ZX with Tri Auto with three novel rotary NiTi systems, in curved mesiobuccal root canals of extracted human first molar teeth.

In this study the root length was maintained in all the teeth, irrespective of the used file system with hybrid instrumentation, comprising of Root ZX mini with Tri Auto mini. The apical anatomy in all the samples was maintained. This combination works similar to TriAuto ZX device, as claimed by manufacturer, which is based on a ratio method, which precisely locate the apical extent of root canal and prevent over instrumentation. [2,14] Uzun et al calibrated the length with the auto reverse function of the Tri Auto ZX device and found 95% accuracy. [10] Felippe et al concluded that apical reverse function of Tri Auto ZX device was reliable in controlling apical extent of rotary instrument as compared with ROOT ZX II with low speed handpiece. [11] Erdemir et al in his experimental study found that Tri Auto Zx was able to maintain length control with its auto reverse function even in presence of irrigating fluids like NaOCl, 3%, H2O2, 0.2% Chlorhexidine and 17% EDTA. [12] Vasconcelos el al found that both rotary and reciprocating devices were equally efficient in the maintenance of the apical limit without any statistically significant difference when used until the AF. [1] Parente et al concluded that Root ZX II showed accurate results in limiting the instrument extent of with in root canal. [13]

Amongst the tested file systems, preparation time was least with Twisted files, closely followed by Hyflex CM files, while it was maximum with Revo S system. Twisted files and Hyflex CM can work at high rotational speed with high torque, resulting in faster preparation. Revo S comparatively results in slower preparation possibly due to relatively stiff alloy with less flexibility in curved canal.

Twisted Files made from R-phase treatment and surface deoxidation process have twisted design, triangular cross-section, variable pitch and safe-ended tip. [15] These features results in increased cyclic fatigue resistance, flexibility, cutting efficiency and withstand high torsional stress. [4] Hyflex CM files made from specific Controlled Memory NiTi alloy which have symmetrical cross sectional design. These files have high Fatigue resistance with increased flexibility, hence they are suited to prepare curved root canals with superior centering ability. [3] Revo S comparatively results in slower preparation possibly due to relatively stiff alloy with less flexibility in curved canal.

On evaluation of the pre and post-operative radiographs it was found that the Hyflex CM system and twisted files showed slight change the curvature of the root canal. Whereas Revo S file relatively altered the anatomy and the curvature of the root canal. There was no statistically significant difference between Hyflex CM and Twisted files while Revo S displayed significant difference. This difference could be an account of file metallurgy and characteristics. Similar to our findings Saber et al found that Hyflex CM instruments respect original canal curvature and efficiently prepare the curved canals with maximum safety. [16] Peters et also found that Hyflex CM files to be highly flexible, have high torsional resistance and possess high cyclic fatigue resistance as compared to conventional NiTi alloy instruments. [3] Kumar BS et al found that Twisted and Hyflex Rotary Files both efficiently shaped curved with centered preparation with respecting the original shape. [4] Marceliano-Alves MFV found that Twisted File and HyFlex CM possess greater flexibility due to thermal pre-treatment of the alloy resulting in more ductile structure with and reduced magnitude of the restoring forces. [17] Contrary to our study Kishore A et al found that HyFlex CM files showed less canal transportation and efficient centering ability in curved canals as compared to Twisted file system. [20]

During preparation, none of the files fractured within the root canal. Least defects were observed with Twisted Files and Revo S files and maximum with Hyflex CM files. Revo-S files have asymmetrical cross

section with three sharp cutting edges, which improves its ability to negotiate canal curvatures and facilitates progression, resulting in less stress concentration, avoiding the screwing effect, thus minimizing the defects. [5] Hyflex CM's metallurgical properties result in significant alteration in flute structure leading to defect formation during preparation.[18] Similar to our findings Asthana G found that Revo-S showed least visual and stereomicroscopic defects as compared to other system after being subjected to high torsional stress. [7] Sundaram KM et al found that Twisted files possess better cyclic fatigue resistance and develop fever defects as compared to Revo-S files. [21] The higher incidence of defects observed with Hyflex CM files can be explained on the bases of finding of a study carried out by Sudani DA who concluded that Hyflex CM although relatively efficient in preparing the canal is prone to unwinding of the flutes under pressure and torque. Stable martensite phase presents in Hyflex CM files has shape memory effect, resulting in easy deformation. [19] Contrary to our finding Capar et al found HyFlex CM files to possess higher cyclic fatigue resistance as compared to Revo-S files, resulting in significant improvement in canal preparation and less defects. [22]

Conclusion:
Hybrid instrumentation is successful in maintaining the working length with root canal shape and curvature. Newer rotary instruments retains the original canal shape, develop defect to a lesser extent, are more resistant to fracture and efficient in preparing the canal.

Table 1: Comparison of degree of straightening of curved canals after canal preparation with different file systems.

| File system	Straightening (°)	
	Mean ± SD	Min-Max
Hyflex CM	1.10 ± 1.16	0.00-3.00
Twisted Files	1.17 ± 1.15	0.00-3.00
Revo-S	4.17 ± 1.26	1.00-6.00
Kruskal-Wallis test	χ^2 = 49.450, df = 2, P = 0.000 (<0.001), Very high significant	
Mann-Whitney U test	Revo-S > Hyflex CM = Twisted Files	

Table 2: Comparison of preparation time between different file systems.

| File system	Preparation time (seconds)	
	Mean ± SD	Min-Max
Hyflex CM	238.20 ± 18.43	198.00-285.00
Twisted Files	229.77 ± 18.56	191.00-279.00
Revo-S	281.57 ± 14.41	249.00-326.00
One-way ANOVA	F = 77.951, P = 0.000 (<0.001), Very high significant	
Tukey post hoc test	Revo-S > Hyflex CM = Twisted Files	

Table 3: Comparison of defects in files between different file systems.

| File system	Defects		Total
	Yes	No	
Hyflex CM	09 (30.00)	21 (70.00)	30 (100.00)
Twisted Files	07 (23.33)	23 (76.67)	30 (100.00)
Revo-S	07 (23.33)	23 (76.67)	30 (100.00)
Total	23 (25.56)	67 (74.44)	90 (100.00)
Chi-square test	χ^2 = 0.467, df = 2, P = 0.792 (>0.05), Not significant		

Graph 1: Comparison of degree of straightening of curved canals after canal preparation with different file systems.
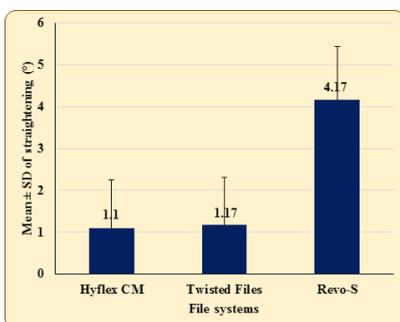
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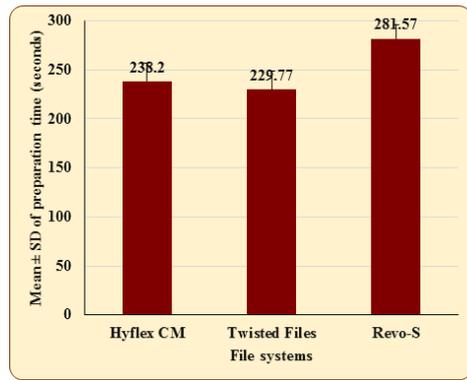
Graph 3: Comparison of defects in files between different file systems.
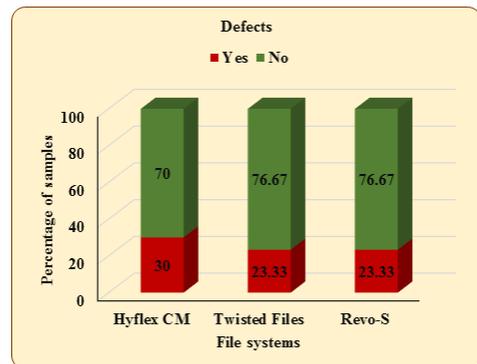
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