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Evaluation of Apical Transportation with Two Rotary Path File Systems versus Hand Stainless Steel Files Using ComputedTomography

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Abstract:*The main aim of the root canal preparation is to remove the infected debris and residual pulp tissues. Shaping the root canal provides more efficient disinfection by creating a reservoir for irrigants and medicaments and also provide space for canal filling. Stainless steel files are less flexible and tends to result in procedural errors. To minimize these errors coronal enlargement and the prior creation of glide paths should be done.*

Recently Ni-Ti rotary path files were introduced which are more flexible and cause less aberrations. In this study we have compared the apical canal transportation with two rotary path files system and hand stainless steel file system using computed tomography.

Thirty freshly extracted mandibular premolar teeth were divided into three different groups consisting of ten samples in each group. Each group were scanned using SOMATOM DEFINITION 60032, Germany digital imaging (spiral CT with 128 slices) for pre-instrumentation dimensions. Then the respective groups were subjected to bio- mechanical preparation with hand stainless steel K-files and rotary path files.

For all the groups irrigation was done with 5.25% sodium hypochlorite, 0.9% saline after use of each file with a disposable syringe and glyde was used as a lubricant before and after use of each file.

After bio mechanical preparation, each group were further scanned with CT for post instrumentation canal dimensions.

The data from the CT scan was tabulated pre and post in each group with measurement from buccal, lingual, mesial and distal sides at apical level. The values were statistically analysed and conclusion were drawn from the study that stainless steel hand K-files have got higher mean transportation as compared to rotary path files.

Keywords:*Apical transportation, computed tomography, curved root canal, Ni-Ti files, rotary instruments.*

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I. Introduction

Proper bio-mechanical preparation of root canal system is the key to successful endodontic treatment. The main aim is to remove the infected debris and residual pulp tissues. Various hand and rotary instruments and techniques have been introduced to prepare root canals(Pitt Ford et al 2002).

Introduction of Ni-Ti files were a major breakthrough due to its superior flexibility and tends to result in less procedural errors(Versumer et al 2002). To minimize these errors prior creation of glide path should be done.

Recently Ni-Ti rotary path files were introduced with a square cross section which increases its torsional stresses and flexibility is enhanced by the low .02 taper which is responsible for high resistance to flexural stresses (Dhingra and Manchanda 2013).

Computed tomography was used for the measurement of canal transportation as appropriate sections can be prepared at any level and viewed without loss of specimen (Gambill and Marden1996).

Considering these facts, the present in-vitro study was undertaken to observe and measure the apical canal transportation of mesiobuccal canal (MB) of maxillary 1st molar of unprepared and prepared root canal with two rotary path files and hand stainless K-files using CT scan.

II. Material and methods

The present in-vitro study was conducted in the Department of Conservative Dentistry and Endodontics, Babu Banarasi Das College of Dental Sciences, Lucknow with the imaging facility of CT scan available at Sarkar Diagnostic Centre, Maha Nagar, Lucknow, India. Mesiobuccal canals of thirty maxillary 1st molars, extracted for periodontal reason were used for this study.

Study Design: Anin-vitrostudy.

Study Location: Department of Conservative Dentistry and Endodontics, Babu Banarasi Das College of Dental Sciences, Lucknow with the imaging facility of CT scan available at Sarkar Diagnostic Centre, Maha Nagar, Lucknow, India.

Study Duration: October 2014 to December 2015.

Sample size: 30 teeth.

Sample size calculation: Thirty maxillary 1st molars, extracted for periodontal reason irrespective of gender and age. The mesiobuccal root canals were used for this study. After cleaning the samples root surfaces debrided with hand scaler and stored in 10% formalin till further used.The thirty teeth were divided into three groups; each group containing 10 samples (n=10)

Samples & selection methods: The sample size was randomly assigned into 3 groups comprising of 10 teeth in each group.
Group A- 10 teeth instrumented using hand stainless steel K-files (Dentsply Maillefer, Ballaigues, Switzerland)
Group B- 10 teeth instrumented using rotary path files (Dentsply Maillefer, Ballaigues, Switzerland)
Group C- 10 teeth instrumented using HyFlex rotary glide path files-(Coltene**,** USA)
The working length of the mesiobuccal canals were then calculated and the canal preparation was done up to the radiographic apex. For all the groups irrigation was done with 5.25% sodium hypochlorite, 0.9% saline after use of each file, with a disposable syringe and glyde was used as a lubricant before and after use of each file.

Inclusion criteria:
1. Mesiobuccal root of the maxillary 1st molar.
2. Teeth sample are extracted due to poor periodontal conditions.

Exclusion criteria:
Teeth with any root fracture were discarded.
Absence of MB2 canal after radiographic evaluation.
Root resorption.

Procedure methodology

Mesiobuccal canals of thirty maxillary 1st molars, extracted for periodontal reason were used for this study. After cleaning the samples root surfaces debrided with hand scaler and stored in 10% formalin till further used. The crowns were flattened perpendicular to long axis of the teeth using diamond disc 0.25mm thick (Isomet, Buhler) in low speed straight hand piece (NSK, Japan) at cemento-enamel junction for avoiding crown disturbance.

The thirty teeth were divided into three groups; each group containing 10 samples (n=10). All samples then mounted on a wax template so that a constant position could be obtained. The pins were placed at the MB canal and end of each row for the determination. CT images were obtained before instrumentation using SOMATOM DEFINITION 60032, Germany digital imaging (spiral CT with 128 slices). Images at high resolution of 120KV, 90mA and scan time was 8 seconds. The apical section which was 3mm from the apical end of the root recorded by using magnetic optical disc.

Access cavities were prepared by using Endo-Access and Endo-Z burs (Dentsply) to gain a straight line access. The working length calculated and preparation was done up to the radiographic apex. For all the groups irrigation was done with 5.25% sodium hypochlorite (Triveni chemicals, India), 0.9% saline (NS- Albert David Ltd, India) after use of each file, with a disposable syringe and glyde (Dentsply, Switzerland) was used as a lubricant before and after use of each file.

In Group I teeth were prepared using hand stainless steel k-files (Dentsply) with watch winding and push-pull motion. Sequence was no 06, 08, 10, 15, 20 with 2% taper.

In II group preparation done using Rotary path files (Dentsply) and in group III using HyFlex GPF (Coltene). In both II and III Group initial glide path has been established by using size 10 K-file to the working length then rotary path files size- .02/13, .02/16, .02/19 used at 300 rpm- 3-5 Ncm torque and .01/15, .02/15, .02/20 used at 300 rpm- 2.4 Ncm torque respectively with CanalPro rotary hand piece (Coltene, USA). All files used with an in and out motion until working length is reached for 3-5 seconds.

Evaluation of the apical canal transportation

The apical canal transportation was determined by comparing the shortest distance from the edge of uninstrumented and instrumented canal to the periphery of the root mesiodistally and buccolingually. (Fig.1 and Fig. 2)

A1 and a_2- shortest distance from the mesial edge of curved root to the mesial edge of the uninstrumented and instrumented canal respectively.

B1and b_2- shortest distance from the distal edge of curved root to the distal edge of the uninstrumented and instrumented canal respectively.

C1and c_2- shortest distance from the buccal edge of curved root to the buccal edge of the uninstrumented and instrumented canal respectively.

D1and d_2- shortest distance from the lingual edge of curved root to the lingual edge of the uninstrumented and instrumented canal respectively.

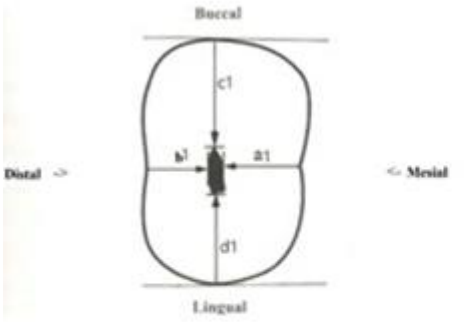

Fig.1uninstrumented canal

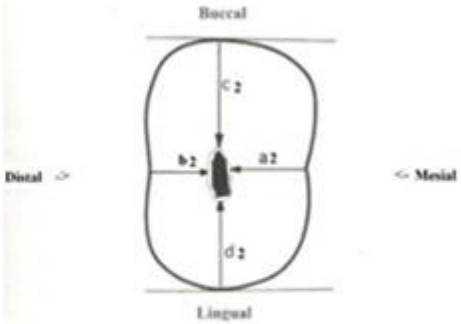

fig.2 instrumented canal

Statistical analysis

The statistical analysis was done using SPSS (Statistical Package for Social Sciences) Version 15.0 statistical Analysis Software. The values were represented in Number (%) and Mean±SD. The ANOVA test was used to compare the within group and between group variances amongst the study groups. Analysis of variance of different study groups at a particular time interval revealed the differences amongst them. The level $p > 0.05$(not significant),$p < 0.05$(Significant).

III. Results

Canal transportation: In mesial direction mean absolute transportation ranged from 0.035±0.018 mm (Group III), 0.051±0.028 mm (Group II) to 0.052±0.014 mm (Group I). Statistically, the difference among groups was not significant (p=0.142).

In distal direction, mean absolute transportation ranged from 0.027±0.008 mm (Group III), 0.055±0.032 mm (Group II) to 0.047±0.016 mm (Group I). Statistically, the difference among groups was significant (p=0.018).

In buccal direction, mean absolute transportation values ranged from 0.049±0.027 mm (Group III), 0.086±0.021 mm (Group II) to 0.085±0.026 mm (Group I). Statistically, intergroup difference was significant (p=0.003).

In lingual direction, mean absolute transportation values ranged from 0.052±0.030 mm (Group III), 0.103±0.031 mm (Group II) to 0.092±0.030 mm (Group I). Statistically, intergroup difference was significant (p=0.002).

Between Groups I and II, the transportation was higher in Group I as compared to Group II at mesial location whereas at all the other directions transportation was higher in Group II as compared to Group I. However, for none of the directions, the difference between two groups was significant statistically (p>0.05).

Between Groups I and III, Group I had higher mean transportation as compared to Group III at all the directions but difference was significant statistically only at buccal and lingual directions. Between Groups II and III had significantly lower mean transportation as compared to Group I. (Table. 1)

In all the directions mean percentage transportation was minimum in Group III and maximum in Group I. In all the directions, the difference in percentage transportation among different groups was significant ($p<0.05$). (Table. 2)

Proportional shift:

Overall, percentage shift from centre ranged from 0.3 to 14.8%. Mean percentage shift ranged from 0.79±0.42% in Group III to 6.45±4.75% in Group I. In Group II, mean percentage shift was 3.01±2.33%. Statistically, the difference in percentage shift was significant among different groups ($p<0.001$).

Mean proportional shift was maximum in Group I and minimum in Group III. Both Groups II and III had significantly lower mean shift as compared to Group I. (Table. 3)

Table 1: Comparison of Absolute Transportation at Mesial, Distal, Buccal and Lingual directions in different groups.

	Apical Transportation							
File Systems	Musial		Distal		Buckle		Lingual	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Group I	0.0052	0.014	0.047	0.016	0.085	0.026	0.092	0.030
Group II	0.051	0.028	0.055	0.032	0.086	0.021	0.103	0.031
Group III	0.035	0.018	0.027	0.008	0.049	0.027	0.052	0.030
ANOVA (F)	2.100		4.653		7.236		7.865	
"P"	0.142		0.018		0.003		0.002	

SD: Standard deviation. All measurements in millimetre (mm)

Table 2: Between Group Comparison of percentage transportation at Mesial, Distal, Buccal and Lingual directions (Tukey HSD test)

File System	Mesial			Distal			Buckle			Lingual		
Groups	Mean	SE	'p'	Mean	SE	'p'	Mean	SE	'p'	Mean	SE	'p'
I vs II	7.07	5.97	0.473	3.64	5.12	0.759	7.08	5.68	0.436	8.64	5.15	0.232
I vs III	21.94	5.97	0.003	22.19	5.12	0.001	30.29	5.68	<0.001	38.39	5.15	<0.001
II vs III	14.88	5.97	0.049	18.55	5.12	0.003	23.21	5.68	0.001	29.74	5.15	<0.001

SD: Standard error. All measurements in millimetre (mm)

Table 3: Comparison of Overall Proportional Shift in different groups

File Systems	Mean	SD	Minimum	Maximum
Group I	6.45	4.75	1.4	14.8
Group II	3.01	2.33	1.1	8.8
Group III	0.79	0.42	0.3	1.6

F (ANOVA) =8.682; $p<0.001$ NS=Not significant; *=Significant at 95% confidence; **=Significant at 99% confidence; ***Significant at 99.9% confidence. All measurement in millimetre.

IV. Discussion

A number of procedural errors can occur during the cleaning and shaping of narrow and curved canals. Among all apical canal transportation i.e the removal of the canal wall structure on the outside curve in the apical half is a routine finding. Stainless steel files have better cutting efficiency but are less flexible leading to difficulties in preparing curved canals. The Ni-Ti instrument have been used as an alternative because of its superior bio-compatibility and super-elasticity (Schafer and schlingemann 2003).

Several studies have been conducted but none of them reported comparative evaluation of apical transportation by hand stainless steel files and rotary path files using CT scan. In the present study this comparison was done.

CT was chosen for the advantage of being non-invasive and measurable sections can be prepared and possible to compare the anatomic structure of root canal before and after instrumentation.

In this study natural teeth has been used which has an advantage that it reflects the dentinal structure and rigidity of the root canal while in resin blocks friction developed by rotary instrument can cause melting (Rhodes *et al* 2011). MB canals of maxillary 1st molar has been used which supports the clinical instrumentation techniques used for the curved canals. Apical transportation was evaluated only at 1mm from the apex as maximum curvature can been seen 0.5 to 1mm of the root apex and change in the position of apical foramen is best evaluated at this level (Tsesis *et al* 2008).

Various studies have found that rotary Ni-Ti instruments are better in preserving the original canal shape in extremely curved canals (Glosson *et al* 1995). However, few studies reported no difference between stainless steel hand Instruments and rotary Ni-Ti systems regarding root canal transportation(Guelzow et al 2005).

Similarly, (Pasqualini *et al* 2012) found no differences by using K-type files and path files in apical transportation. In contrast (Berutti *et al* 2009)suggested that NiTi rotary path file instruments cause less procedural errors when compared with K-files.

Manual (with hand files) or mechanical (with rotary files)creation of .02 tapered glide path is essential for the safe and effective use of rotary instruments.

Studies suggested that a manual creation of a glide path with hand stainless steel instrument can effectively reduce the transportation(Peters 2004).

The hand stainless steel K-files have 1 ½ to 2 ½ cutting blades per mm of their working end and about twice the number of spirals on a K- reamer of corresponding size. Produced mainly from square blank which resist fracture better but since flutes are twisted to produce more flutes per mm, files remove tooth structure faster.The main advantage of the stainless files is the better cutting efficiency but are less flexible when compared to Ni-Ti instruments which are two to three times more flexible than conventional stainless steel files (Peet 2011).

The tip of the rotary path files is rounded and non cutting to avoid ledging and zipping. They have a square cross section which increases the resistance to torsional stresses and four cutting angles increases the efficacy even in calcified canals(Dhingra and Manchanda 2013).The distance between the following blades has been optimize to increase the strength of the instruments. The flexibility is enhanced by the low .02 taper.

The mechanical instrumentation cannot sufficiently disinfect root canals. It is recommended to use antibacterial irrigants in combination with chelating agents. In this study we have used Ethylenediaminetetraacetic acid (EDTA) - GLYDE as chelating agent and Sodium hypochlorite (5.25%) with saline as irrigant to follow full irrigation protocol(Bystrom and Sundovist 1985).

The data from the present study leads to the assumption that HyFlex GPF (Group III) adapts the canal space anatomy better and cause minimum apical canal transportation while the hand stainless steel file (Group I) cause maximum.

HyFlex GPF it is manufactured by unique process that controls the material's memory which is 2-3 times more flexible. Constant pitch helps in the movement of the file to the tip with maintaining the canal curvature. Variable taper- the 1st file used with taper of 1% then with 2%. Thus smaller the taper lesser will the transportation and cutting.These files havemore strength, toughness and resistance to angular deflection. They are more resistant to cyclic fatigue and has got better fracture resistance. The variable taper (1% and 2 %) and flexibility of the HyFlex GPF are the main factors which made the differences in the amount of apical transportation compared to other groups.

Hence further studies are required as the present study had limitations being an in-vitro one and results may differ in clinical situations.

Limitations of the present in- vitro study is the variation in the curvature of the sample teeth, Observation and measurement of the amount of apical transportation.

V. Conclusion

Considering the results and observations pertaining to apical transportation, Rotary path files adapts the canal space better and cause minimum apical transportation when compared to hand stainless steel K-file. In all

directions mean percentage transportation and mean proportional shift was minimum with HyFlex GPF and maximum with hand stainless steel K-files.

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