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Comparative analysis of changes in working length in curved canals after using three different file systems

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Abstract

Aim: To compare and analyze changes in working length in curved root canals before and after instrumentation with different file systems (Stainless steel, Protaper next, Hy flex CM).

Method: Mesial root canals of molars having curvatures of 20^0 to 45^0 were selected with Schneiders method. Working length (WL) determination was done with a 10-k file for all three groups. Cleaning and shaping was done according to manufacturer's instructions and post instrumentation WL was determined. All readings were noted and tabulated. Results: The observed difference in working length pre and post instrumentation was as follows- Hand K files- 0.1117± 0.25, Protaper Next- 0.0158 ± 0.05, (Stainless steel) than Hy flex CM –0.0442 ± 0.17. Statistical analysis was done using Kruskal Wallis test.

Conclusion: There was no statistically significant difference between all files as regards change in working length. However, Protaper Next caused the least change in working length post instrumentation in curved root canals followed by Hy flex CM. Hand K files caused the highest change in working length post instrumentation in curved canals.

Keywords: working length, canal curvature, instrumentation

Introduction

"Any technology that is sufficiently advanced is indistinguishable from magic". This is very apt to describe the clinical practice of endodontics which has experienced path-breaking innovations over the years. Development of innovative technology and materials over the last decade has helped to improve patient outcomes by improving the precision, efficiency and accuracy of endodontic procedures. The need for precision and accuracy is particularly important in the field of Rotary endodontics. [1,2]

A complete debridement of pulpal tissue and necrotic debris, along with optimum shaping of the root canal system is one of the primary goals of endodontic therapy. The ability to enlarge a root canal without deviating from its original canal curvature is a primary objective in endodontic instrumentation.

The working length of a root canal is the distance calculated between the coronal reference point to the point at which the canal preparation should terminate. Working length can be assessed by means of radiographs, apex locators or by paper points or tactile sensation.

Regardless of the method used, it is imperative that the clinician maintains this length throughout the endodontic procedure.

If the working length (WL) changes during cleaning and shaping procedure, it becomes challenging to predict the depth of the root canal, and is observed mainly in cases with curved canals.[3] Weine et al. reported that straightening of the canals led to decrease in WL during the course of treatment.[4]

This in turn would cause inadvertent over-instrumentation of the canal. The predictable sequalae is overextension of obturating materials, damage to the periapical tissues, pain and flare-ups.

It can also adversely affect the prognosis of endodontic treatment.

Maintaining consistency of working length in curved canals is a challenging task.

A plethora of endodontic hand and rotary file systems are available to the clinician for cleaning and shaping procedures. Hence this study is aimed to study and compare before and after instrumentation working length changes in canals that are curved, using two rotary file systems viz, the Protaper Next (Dentsply, Mallifier Ballaigues, Switzerland) and Hy flex CM (Coltene, Whale dent) files and hand k Stainless steel (MANI Delhi India) files.

Materials and methods

This in-vitro study was carried out at DY Patil University School of Dentistry Navi Mumbai. 36 extracted human first and second molar teeth from both the maxillary and mandibular regions were selected. Inclusion criteria comprised of teeth with curved canals (20^0 to 45^0 curvature), having normal pulp chambers, patent root canals, normal root morphology, having no apparent defects, no resorption, with mature apices. Teeth having calcifications or S-shaped root canals (detected radiographically) were excluded.

Sample Preparation

A carbide bur #10 and #14 (SS White Gujarat, India) and Endo Z bur (Dentsply, Sirona, USA) with an air rotor hand piece were used for coronal access preparation in each specimen.

Measurement of canal angulation

Schneider's method was used to determine the canal curvature of the root. The Schneiders method involves marking a point in the middle of the file at the level of the canal orifice.

A straight line is drawn, which is aligned parallel to the file image from point “a” to the point where the instrument deviates from the line, designated as point “b”. Point “c” is marked at the apical foramen and a line is drawn from this point “a” to point “b”.

The angle which was formed by the intersection of these two lines was measured and noted as the canal curvature.[5] Mesio-distal roots having curvatures between 20° and 45° were chosen.

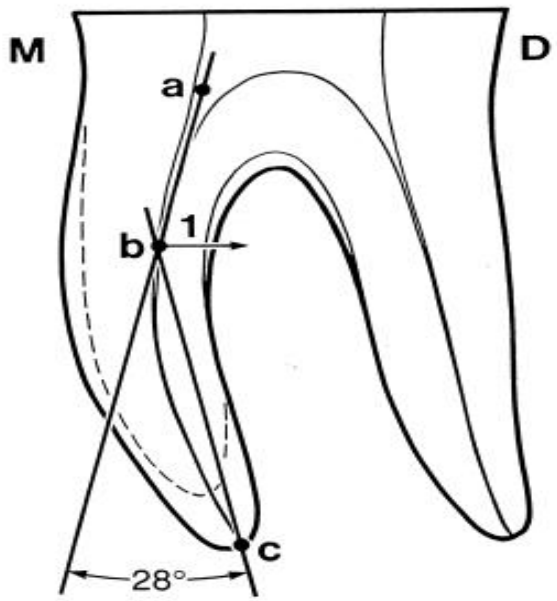

Fig 1: Schneiders Method to determine canal curvature.

Measurement of Working Length before intracanal instrumentation

The occlusal surface of each sample was flattened by means of a model trimmer in order to achieve a consistent reference point for WL determination. A #10 K file was introduced into the selected root canal of each specimen. The location at the root apex where the file first appeared at the apical foramen was observed and noted. Then a glass slab (barrier) was placed against the apical foramen. The #10 K file was reintroduced in the root canal and inserted till it stopped against the glass barrier. WL was measured by means of a Digital caliper (Aerospace 300 mm Digi Matic Vernier Caliper) in millimeters using flattened coronal surface as a reference point. This length was designated as pre instrumentation WL. The pre-instrumentation WL was measured twice for each root canal and its mean value was noted as the WL.

All the 36 specimens were divided randomly into 3 subgroups viz. Group 1 –SS hand K file group, Group 2- ProTaper Next group and Group 3 -Hy flex CM group.

In Group 1, coronal preflaring was done using Gates glidden (MANI) drills, following which instrumentation with K files was done with step-back technique. All samples were enlarged till an apical preparation of #25 k file.

In Group 2, teeth were instrumented with Protaper Next system, following manufacturers recommendation. Coronal pre-flaring was done with Sx file. Apical preparation was done till X2 file. (025/06).

In Group 3, Cleaning and shaping was completed with Hy flex CM files according to manufacturer's recommendations. Final finishing was done by using no 25/06 taper files.

In all specimens, a solution of 5.25% sodium hypochlorite (Dentproof, India) was used to flood the root canal. #10 K file was used to verify the apical patency. Root canal irrigation was carried out using 1 ml of this sodium hypochlorite. After the cleaning and shaping, post instrumentation WL was determined as delineated previously.

All readings were noted and tabulated. The difference in pre and post instrumentation WL was calculated for each specimen. (Table 1,2,3)

Results and statistical analysis

The mean values of difference in working length pre and post instrumentation was as follows- Hand K files- 0.1117± 0.25, Protaper Next- 0.0158 ± 0.05, (Stainless steel) than Hy flex CM –0.0442 ± 0.17. Protaper Next caused the least change in working length post instrumentation in curved root canals followed by Hy flex CM. Hand K files caused the highest change in working length post instrumentation in curved canals.

Kruskal Wallis test was used for Statistical Analysis. There was no statistically significant difference between all files as regards change in working length. (Table 4)

Discussion

It is extremely important to accurately determine the working length of the root canal, to enable the clinician to easily remove necrotic tissue and precise preparation of root canals, thereby leading to better outcomes.

Current evidence suggests that NiTi files lead to a more centered canal that is very close to the original. However, when left within the canal for too long, they straighten it.[7]

Chelating agents help in cutting of dentin and preventing binding of instruments in the canal, and their use has been recommended in such cases.[8]

WL determination becomes more critical in curved canals as it was found that root canals tend to straighten out during instrumentation thus changing the WL. This can lead to over instrumentation and its further complications.

Formerly, instrumentation of all types of canals was done using stainless steel instruments. These instruments tend to straighten out the canal when advanced progressively to larger sizes.[9]This unfortunately can lead to zipping, ledge formation, strip formation and sometimes, even perforations. This is primarily due to the stiffness and inflexibility of the stainless-steel instrument.

The introduction of NiTi instruments by Walia, Brantley solved many of these drawbacks. These instruments have several advantages over conventional stainless-steel instruments, in terms of flexibility and superior cutting efficiency. They also offer the advantage of helping create centered preparations faster, as well as produce tapered root canal preparations with lesser chances of canal transportation.[10] So this study was undertaken to assess the efficacy of hand files and 2 rotary systems, viz Hy flex CM & Protaper Next files, and assess if they managed to retain the original working length of a curved root canal.

In our study, the same operator performed all the endodontic treatments. Except for the shaping protocol, which followed the manufacturer's instructions, all other parameters, i.e the materials and methodology were kept the same. A strict implementation of the inclusion criteria was maintained. Only patent root canals with 20^0 to 45^0 curvatures, without calcifications and resorptions were selected.

Hy flex CM files

The Hy flex CM multiple-file system (Coltene whale dent, USA) is created from a Controlled Memory (CM) wire that had undergone thermo-mechanical surface treatment, improving the fatigue resistance performance of the file. All these features of the CM instruments provides higher flexibility and enables the instruments to maintain the original canal anatomy, thereby minimizing the risk of transportation as well as enhancing the safety during instrumentation.[11]

Protaper Next files

Snake like motion because of off-centered rectangular cross section is a unique feature of thermo mechanically processed files. The shaping time is reduced by the high cutting efficiency. Metallurgical properties like the presence of martensitic phase in NiTi alloy (M wire) provides less stiffness and reduced restoring force to the instruments, by ensuring less apical extrusion at a similar torque as compared to the austenitic NiTi alloy.[12,13,14]

In our study, the pre and post instrumentation WLs were checked for Protaper Next files, Hy flex CM, Hand K files and the difference between them was recorded.

The results showed that the mean difference in pre and post instrumentation WLs was Protaper Next (0.0158) Hy flex CM (0.0442) and Hand files (0.1117). (Table 4)

The least change in WL was recorded by Protaper Next files, followed by Hy flex CM, followed by Hand K files. Moreover, out of the 12 curved roots tested, 9 teeth in Group 2 (Protaper Next) showed no change in WL, thus indicating highest accuracy. Group 1 (K files) and group 3 (Hy flex CM) had 2 and 3 teeth respectively showing no change in WL. However, the results were not statistically significant.

A similar study by Davis et al compared pre and post instrumentation changes in WL between stainless steel and NiTi files.[15 Canal] preparation led to a decrease in WL for all canals. The SS group showed a significantly greater mean decrease in WL as compared to the NiTi group.

A Study by Rahul K et al also reported a significantly greater mean decrease in WL for the SS group than for the Ni-Ti group.[16]

Our study also indicated that there is some change in curved root canals' WL, irrespective of the file system used. Hence it is recommended to measure the WL of a curved root canal at least one more time during instrumentation.

Since this was an in vitro study, more in-vivo studies and clinical trials are required to substantiate these results.

Conclusion

1. There is change in WL in curved root canals during instrumentation regardless of the file system used.
2. Protaper Next resulted in the least working length change post-instrumentation in curved root canals followed by Hyflex CM files. Hand K files led to the highest working length change post instrumentation in curved canals. However, the results did not show statistically significant difference between the file systems.
3. Protaper Next files showed highest accuracy in WL measurement in curved root canals.
4. While instrumenting curved canals, it is recommended that WL be checked more than once.

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Results and Statistical Analysis

Table 1: Group 1 -HAND k file

Sn.	Pre-instrumentation working length	Post instrumentation working length	Difference in working length.
1	18.25	18.21	0.04
2	18.3	18.47	-0.17
3	13.94	14.04	-0.10
4	13.26	13.45	-0.19
5	21.08	21.08	0.00
6	19.70	19.19	0.51
7	18.34	18.36	-0.02
8	17.82	17.31	0.51
9	19.33	19.33	0.00
10	19.455	19.18	0.275
11	20.25	20.21	0.04
12	20.94	20.50	0.44

Table 2: Group 2 - Protaper Next rotary files

Sn.	Pre-instrumentation working length	Post instrumentation working length	Difference
1	19.53	19.53	0
2	18.48	18.48	0
3	16.42	16.42	0
4	16.07	16.07	0
5	18.3	18.12	0.18
6	17.21	17.20	0.01
7	22.15	22.15	0
8	22.44	22.44	0
9	21.55	21.55	0
10	18.31	18.31	0
11	19.53	19.525	0.005
12	18.25	18.25	0

Table 3: Group 3- Hy flex CM rotary files

Sn.	Pre-instrumentation working length	Post instrumentation working length	Difference
1	17.73	17.75	- 0.05
2	16.375	16.25	0.125
3	14.32	14.32	0
4	16.05	16.05	0
5	16.375	16.38	-0.005
6	12.535	12.57	-0.035
7	14.08	14.315	-0.235
8	15.07	14.895	0.175
9	17.07	17.06	0.01
10	18.56	18.56	0
11	13.84	13.33	0.51

Table 4: Comparison of Difference of Pre -instrumentation and post-instrumentation working lengths

Descriptive Statistics

	Mean	Std. Deviation	Std. Error	Minimum	Maximum	N
Hand file	.1117	.25605	.07391	-.19	.51	12
Protaper	.0158	.05178	.01495	.00	.18	12
Hy flex CM	.0442	.17620	.05086	-.24	.51	12
Total	.0572	.18129	.03022	-.24	.51	36

Interpretation

The observed difference is highest in Hand files, then Hy flex CM and least was Protaper Next.

Kruskal-Wallis test result

Test Statistics[a, b]	
	Value
Chi-Square	.311
Df	2
Asymp. Sig.	.856

a. Kruskal Wallis Test

b. Grouping Variable: Groups

Interpretation

Since p-value for the K-W test is greater than that of 0.05 indicates that average change in all the groups taken from pre data is not significant.

Graph 1: Mean difference in pre and post instrumentation working lengths