Comparing the Cutting Efficiency of Three Ni-Ti Rotary Files in the Curved Root Canals

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بسم الله الرحمن الرحيم

قَالُوا سُبْحَانَكَ لاَ عِلْمَ لَنَا

إِلاَّ مَا عَلَّمْتَنَا إِنَّكَ أَنتَ الْعَلِيمُ الْحَكِيمُ

صدق الله العظيم

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Dedication

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List of Contents

Page

1- Introduction……..……..... 1

2- Review of Literature……..…….....…….....3

a) **Cutting Efficiency of systems under investigation…… 3**
b) **Shaping Ability of systems under investigation……... 16**

3- Aim of the Study…….…….....…..... 33

4-Materials & Methods….....……... 34

a) **Materials…….. 34**
b) **Methods…… 36**

5-Results…….....…….....47

a) **Evaluation of cutting Efficiency for systems under investigation……. 47**
b) **Evaluation of shaping Ability for systems under investigation…….…… 60**

6-Discussion...……...……..…. 74

7- Summary and Conclusion……...……... 87

8- References……...…… 90

9- Arabic summary……... 102

List of Abbreviations

NiTi file	An endodontic file made from Nickel and Titanium alloy.
PU	Protaper Universal rotary file system.
RS	Revo-S rotary file system.
HF	HyFlex CM rotary file system.
CBCT	Cone Beam Computed Tomography imaging technique.
ROI	The Region Of Interest on imaging the specimens.
FOV	The Field Of View on imaging the specimens.
NaOCl	Sodium Hypo-chloride irrigating solution.
EDTA	Ethylene Di-amine Tetra Acetic acid irrigating solution.
rpm	The number of revolutions per minute that the rotary file made on working.
MB canal	The Mesio-Buccal root canal.
MD	The Mesio-Distal dimension.
BL	The Bucco-Lingual dimension.
m ± SD	The statistical mean ± the standard deviation value.

List of Tables

Table No.	Table Title	Page No.
1	Mean and standard deviation values for the total dentine removal at each canal level for the experimental group (I)	50
2	Mean and standard deviation values for the total dentine removal at each canal level for the experimental group (II)	50
3	Mean and standard deviation values for the total dentine removal at each canal level for the experimental group (III)	51
4	Comparing the mean and standard deviation values for dentine cutting by each rotary system used at different canal levels	52
5	Mean and standard deviation values of cutting efficiency regarding Rotary system and Canal curvature	57
6	Mean and standard deviation values of the cutting efficiency of rotary file systems	58
7	Mean and standard deviation values for change in the angle of curvature in degrees for subgroups (A)	61
8	Mean and standard deviation values for change in the angle of curvature in degrees for subgroup (B)	62
9	Mean and standard deviation values of the straightening occurred in the angle of canal curvature in degrees	66

Table No.	Table Title	Page No.
10	Mean and standard deviation values of Mesio-Distal Transportation for subgroups (A)	69
11	Mean and standard deviation values of Mesio-Distal Transportation for subgroups (B)	69
12	Mean and standard deviation values of the dentine cutting for the experimental group I (PU file)	71
13	Mean and standard deviation values of the dentine cutting for the experimental group II (RS file)	72
14	Mean and standard deviation values of the dentine cutting for the experimental group III (HyFlex CM file)	73

List of Figures

Figure No.	Figure Title	Page No.
1	Representative picture for the Protaper Universal File system.	35
2	Representative picture for the Revo-S File system.	35
3	Representative picture for Hyflex CM File system.	35
4	Representative picture of sample teeth with their distal roots resected and a color codes were written on their buccal aspect.	40
5	A picture showing the i-Cat CBCT scanning machine that was used for the study with specimen placed at the chin seat for scanning.	41
6	A representative diagram showing Schneider's method used for measuring the angle of canal curvature.	41
7	A sample for showing the method of measuring the pre and postoperative canal curvature using the Schneider's method where (a) and (b) representing the pre and post-operative images respectively.	42
8	The X-Smart Endo-motor used for root canal preparation in the study.	42
9	A representative drawing illustrating the method of measuring linear dentine thickness before and after instrumentation.	45
10	A sample for showing the method of measuring the pre and postoperative dentine thickness where (a) and (b) represent the pre and post-operative dentine thickness measures respectively.	45
11	A column chart showing the effect of canal level on cutting efficiency for the experimental groups.	51
12	A column chart showing the effect of Rotary system and Canal level on cutting efficiency.	52
13	Representative figure of dentine thickness measurements at coronal level for PU sample (A-7) where (a & b) represent the pre and post-operative measures respectively.	53
14	Representative figure of dentine thickness measurements at coronal level for PU sample (B-11)	53

Figure No.	Figure Title	Page No.
	where (a & b) represent the pre and post-operative measures respectively.	
15	Representative figure of dentine thickness measurements at middle level for RS sample (A-8) where (a & b) represent the pre and post-operative measures respectively.	54
16	Representative figure of dentine thickness measurements at middle level for RS sample (B-18) where (a & b) represent the pre and post-operative measures respectively.	54
17	Representative figure of dentine thickness measurements at coronal level for HF sample (A-8) where (a & b) represent the pre and post-operative measures respectively.	55
18	Representative figure of dentine thickness measurements at coronal level for HF sample (B-11) where (a & b) represent the pre and post-operative measures respectively.	55
19	A column chart showing the effect of Rotary system and Canal curvature on cutting efficiency.	57
20	A column chart showing the cutting efficiency of each rotary system.	59
21	A column chart showing angle of canal curvature in degrees for subgroups (A & B) Pre and Post-Operatively.	62
22	Canal curvature measurement of sample IA-18 a) Pre-instrumentation b) post-instrumentation.	63
23	Canal curvature measurement of sample IB-12 a) Pre-instrumentation b) post-instrumentation.	63
24	Canal curvature measurement of sample IIA-11 a) Pre-instrumentation b) post-instrumentation.	64
25	Canal curvature measurement of sample IIB-10 a) Pre-instrumentation b) post-instrumentation.	64
26	Canal curvature measurement of sample IIIA-4 Pre-instrumentation b) post-instrumentation.	65
27	Canal curvature measurement of sample IIIB-11 a) Pre-instrumentation b) post-instrumentation.	65

Figure No.	Figure Title	Page No.
28	A column chart showing straightening occurred for the angle of canal curvature in degrees.	66
29	A column chart showing the MD Transportation occurred for both subgroups A and B.	70
30	A column chart showing the effect of different variables on the cutting efficiency for the PU rotary system.	71
31	A column chart showing the effect of different variables on the cutting efficiency for the RS rotary system.	72
32	A column chart showing the effect of different variables on the cutting efficiency for the HF CM rotary system.	73

Cleaning and shaping the root canal considered the most important phase of endodontic treatment. Other aspects of treatment however because they are all interrelated and contribute to the success of endodontic therapy so cannot be neglected. The objectives of cleaning and shaping could be divided into two aspects: to debride and disinfect the root canal system and to shape and contour the root canal walls and apical constriction, for the purpose of sealing the root canal completely with a condensed inert filling material. Also root canal instrumentation should aim to maintain the original configuration of the canal and to create a tapered funnel preparation with increasing the diameter from endpoint to orifice to facilitate effective irrigation and a three-dimensional obturation of the root canal space.

The ability to enlarge the canal without canal deviation, apical transportation or instrument separation is from the primary objectives in the field of endodontics. Stainless steel hand instruments are being used for cleaning and shaping of root canals but they are not efficient enough in preparation of narrow and curved canals due to the instruments inherent stiffness. Larger sizes of stainless steel files can cause alterations in root canals such as strip perforations, ledges, zips and transportation [1,2]. These mishaps urged the development of a new generation of rotary endodontic instruments made of nickel-titanium (Ni-Ti) alloy. The increased flexibility of Ni-Ti instruments aids in safe preparation of curved canals.

The development of Nitinol (an equi-atomic alloy composed of nickel and titanium) has proved to be a significant progress in the manufacture of endodontic instruments. Super elasticity is associated with phase transformation of the alloy upon the application of stress above a critical level. This stress-induced martensitic transformation reverses spontaneously upon release of the stress; the material then returns to its original shape and size. Thus, Nitinol exhibits shape memory, i.e. the ability of the instrument to return to its original shape once the stress is removed. This unique property is due to the austenitic crystalline structure of the alloy [3].

Over the last 25 years since the introduction of the first rotary nickel-titanium (RNT) instrument manufacturers have centered their concern on a desire to obtain both safety and cutting efficiency in the same instrument. RNT safety and efficiency are collectively determined by the design of the file, the manner in which the file is used and the method of manufacturing. NiTi rotary instruments are generally used in a crown-down approach and a continuous reaming motion. Consequently rounder root canal preparation with less straightening and a smaller amount of apical extrusion is achievable. The super elasticity of the NiTi alloy provides increased flexibility and allows the instruments to effectively follow the root canal original path.

The use of computed tomography (CT) scanning has been suggested for evaluation of root canal preparation with good results where it allows a detailed 3D observation of their forms and shapes and measures the amount of dentin removed from the root canal walls. More recently, cone beam computed tomography (CBCT), the latest innovation in CT technology has evolved as a promising tool in endodontic research that could provide a high-resolution 3D imaging.

Hyflex cm file is a NiTi rotary system made from a NiTi controlled memory wire has been introduced since 2011 which exhibit a lower percent in weight of nickel (52 Ni %wt) than the common 54.5–57 Ni %wt shown by the great majority of commercially available NiTi rotary systems. Hyflex cm NiTi Files has been produced by an innovative methodology (patent pending) that uses a unique process that controls the material's memory (a complex heating and cooling treatment). The manufacturer claims that these instruments have flexibility and fatigue resistance superior to conventional NiTi rotary instruments made from super elastic wire. However, these claims by the manufacturers have not been adequately tested by independent research. Therefore, it was thought that evaluation of the effectiveness of cutting, preservation of dentine thickness and maintenance of canal curvature of the Hyflex cm instruments and compares it with other two commercially available conventional NiTi rotary instruments is of value.

No doubt that root canal preparation is an important part of endodontic treatment. The cutting efficiency of the instrument used in root canal preparation is important to develop a shape that tapers from apical to coronal but this should be accompanied with maintaining the original canal shape. So the review of our present study will clarify the cutting efficiency and shaping ability of systems under investigation that were tested in previous studies.

I) Cutting efficiency of systems under investigation:

From the old trials to study root canal before and after preparation was that made by Bramante [4] (1987) who made a technique which was an objective method that was put forth for studying the anatomical morphology of root canals before and after instrumentation in order to make accurate comparison. This method provides a plaster block around a resin-indexed experimental tooth. The block was custom-machined and sectioned in various planes to allow exact repositioning of the complete block or sectioned parts of the tooth. Simultaneous evaluation of numerous parameters such as canal area, shaped form and centering were possible. This method enabled qualitative and statistical studies of root canals before and after instrumentation.

Nahid et al [5] (2008) evaluated and compared canal preparation pattern of K3 and ProTaper rotary files in curved resin blocks. They used twenty-four resin blocks in there experimental study and randomly divided them into two groups. Pre and post preparation images were superimposed by Photoshop software and the removed resin was measured in 5 different points. They found that at O point (orifice) significantly more outer canal wall was removed in the ProTaper group than in the K3 group, there was no significant difference at any other points of outer wall and the removed material of inner canal wall was not significantly different between the two groups. They concluded that both systems performed acceptable preparation pattern except at the beginning of the curve.

Schäfer and Oitzinger [6] (2008) compared the cutting efficiency of Alpha-File, FlexMaster, Mtwo, Protaper and RaCe. They used new .06/25 and .04/35 instruments. The cutting efficiency of all 120 instruments was determined in a rotary working motion by means of a computer-driven