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TYPES OF SURFACE DEFECTS AND INCIDENCE OF FRACTURE AFTER ROOT CANAL PREPARATION USING DIFFERENT SINGLE FILE SYSTEMS AT DIFFERENT TORQUE SETTINGS USING SEM (IN VITRO STUDY)

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ABSTRACT

Objectives:- This study is an attempt to evaluate surface changes and incidence of fracture of One shape and Neoniti rotary files after root canal preparations of lower permanent molars, under different torques, using SEM.

Material and methods: Total 26 files were used, 2 Control (one from each system), Group I (12 oneshape file) and Group II (12 Neolix files), each was further divided into Sub group A(low Torque 2N/cm) and Sub group B (High Torque 4N/cm)respectively.

Results showed that even the new files suffered from surface defects. No used instruments free of surface defects even under low or high torque. Different torques cause statistically significant difference between One shape and Neolix files in terms of disruption of cutting edge and metal flash only.

Conclusion Clinicians should be aware because all files are predisposed to wear and fatigue, so small files should have improved quality control by the manufacturer as they are highly prone to failure especially in curved canals or under high torque or even if single used.

KEYWORDS: Torque,Oneshape,Neolix,SEM

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INTRODUCTION

To get a successful endodontic treatment, practitioner must achieve safe and effective cleaning and shaping of the root canals. This allows effective disinfection and reliable 3D obturation. Traditionally, endodontic instruments were made of carbon steel, which was prone to corrosion. Hence, corrosion resistant »stainless steel alloy« was used as a material of choice for all types of endodontic instruments. But their modulus of elasticity was high which made them less flexible[1]. Lack of flexibility can lead to procedural errors because of the tendency of the file to return to its straight form when used in curved canals [2][3].

The Nickel-Titanium instruments then offered many advantages over these conventional files like super elasticity, shape memory, and lower modulus of elasticity[4]. Also, it gives better shaping, less straightening of the canal [5]. In addition to their time saving and ease of use especially "the single file systems [6][7][8][9]

A new generation of Ni-Ti files has been introduced with different working motion and design features such as the core diameter, cross section, rake angle and flute depth [10]. These affect the behavior of the file, surface changes (Tripi TR et al 2001) [11] [12], cutting efficiency also decreasing of cracks on dentinal wall or debris extruded apically [13].

Despite these advantages they are still prone to failure [14], plastic deformations or even fracture, because of torque or many factors [15] [16] method of manufacture, surface treatment, speed, operator force or canal curvatures [17]

It is necessary to observe the surface changes of rotary instruments because it considered an important factor in failure or fracture initiation [18] [19] Fracture of Ni-Ti instruments could occur with little or no visible evidence of plastic deformation; that could not be visualized without magnification [20] [21]

Therefore, the only predictable way to prevent failure is to discard rotary files regularly after a certain number of uses [6], especially in complex canal preparations; calcified canals & curved canals [2]. Also care must be taken while using these instruments and manufacturer's instructions must be followed.

Hence, the purpose of this study was to show the surface changes and incidence of fracture of different single file systems under different torques[22], using Scan Electron Microscope [23] . So, we gain insight into the mechanism for failure and to minimize the clinical failure of these instruments Tripi TR [11]

MATERIAL AND METHODS

48 human extracted lower first permanent molars were collected, and according to Schneider[2] method, acute angle was measured and classify into mild (less than 25°), moderate (25°-35°) and sever (more than 35^0) where different root curvatures were evenly distributed among the experimental groups[3] .Proper access cavity and occlusal reduction were performed to adjust working length of all teeth 16mm done by one operator to avoid variability. For each tooth sequential crown down technique was done, mesiobuccal canal by **One shape file** taper 0.06 tip size 25(MicroMega, Besancon, France) and mesiolingual by **Neolix file** taper 0.08 tip size 25(Neolix, France), each file prepare 4 canals only. **Manual Stainless-steel K-files size # 10 and 15** (Dentsply, Maillefer, Swiss Made), **Orifice opener C1 Ni-Ti rotary files** (Neolix, France) at speed 350 rpm and torque (2 N/cm if low and 4 N/cm if high) **Endodontic torque and speed control rotary motor.** (NSK, Japan), **Sodium hypochlorite solution** (AMECO, Egypt) was used with (5ml) 30G needle as irrigation, with 17% **EDTA gel** (Dentsply. Meta Biomed Inc., Republic of Korea) as a lubricant.

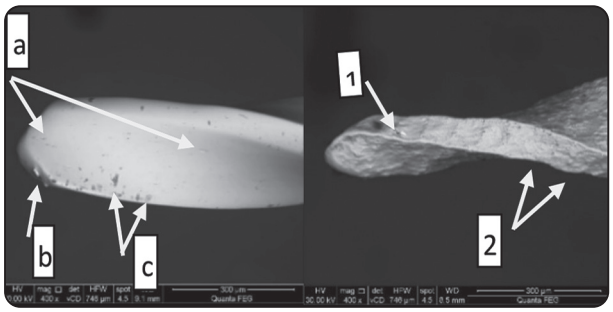
A total number of 26 files were used, 2 Control (one from each system) ,Group I (12 Oneshape file)

and Group II (12 Neolix files), each group divided into Sub group A(low Torque 2 N/cm) and Sub group B (High Torque 4 N/cm).New unused instruments were removed from packaging for microscopic analysis without any cleaning treatment, then all the experimental instruments after use were ultrasonically cleaned in ethyl alcohol **Ultra sonic instrument cleaner** (Guilin Woodpecker Medical Instrument Co), then the apical third of the files was examined at same magnification 400X to evaluate surface changes and defects[11] using **Scanning Electron Microscope (SEM)** (FEL Company, Netherlands). The mean value for each surface defect was calculated for each file. Data were presented as frequency percentage values. Chi square test to compare the groups. Significant level was set at $P \leq 0.05$.

RESULTS

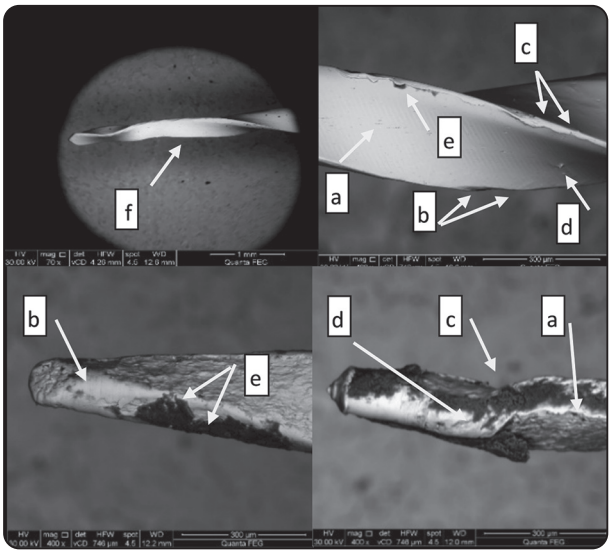
SEM at 400x magnification, of new instruments[11] One shape file showed: - a) Pitting, b) Metal Flash and c) Debris,

While the Neolix file showed 1) Fretting and 2) Disruption of cutting edge.



SEM at 400X magnification, for Group I (One shape file): Low Torque 2 N/cm show: a) Pitting, b) Blunt edge, c) Disruption of cutting edge, d) Metal flash, e) Debris and f) unwinding,

High Torque 4 N/cm show: a) Pitting, b) Blunt edge, c) Disruption of cutting edge, d) Metal flash and e) Debris.



SEM at 400X magnification, for Group II (Neolix file): Low Torque 2 N/cm show: a) Pitting, b) Blunt edge and c) Debris

High Torque 4 N/cm show: a) Pitting, b) Blunt edge, c) Debris, d) Disruption of cutting edge and e) Unwinding.

Comparison of defects distribution and percentage after root canal preparation with One shape and Neolix files used at the same torque used:

TABLE (7) Representing frequency of defects for different files at different torques:

		Pitting	Fretting	Blunt edge	Disruption of cutting edge	Metal flash	Debris	Unwinding	Fracture
Low Torque	**One S.**	6 100%	3 50%	2 33.4%	2 33.4%	3 50%	2 33.4%	1 16.7%	0 0%
	Neolix	4 66.7%	2 33.4%	1 16.7%	6 100%	1 16.7%	5 83.4%	0 0%	0 0%
High Torque	**One S.**	6 100%	2 33.4%	4 66.7%	4 66.7%	4 66.7%	3 50%	0 0%	0 0%
	Neolix	6 100%	1 16.7%	1 16.7%	6 100%	0 0%	5 83.4%	1 16.7%	1 16.7%
P-value		0.0879	0.683	0.212	0.021*	0.058	0.187	0.536	0.372

: Significant at P ≤ 0.05

DISCUSSION

Root canal instruments were subjected to repeated tension-compression cycles in root canals. Both the instrument design and instrumentation technique can influence the magnitude of stress concentration and fracture. So optimum speed and torque must be used following manufacturing instructions.

Rotary Ni-Ti instruments were done by cutting a round blank into a desired cross section by machine milling, so surface imperfections easily formed, may fracture without warning even with new [24], although most deformations occurred after multiple uses [5]

Mechanically, failure occurred because applied force exceeds its ultimate strength of the file. [12] The chance for fatigue failure much greater in engine-driven instruments than in hand-operated instruments (because they rotate at a low rate) and the number of strain cycles was the main determinant of the fatigue life of a material [1] So the single used file had a great benefit in these points. Which reduces, but does not eliminate, the risk of fatigue or fracture [22]

The present study was aimed to evaluate the surface changes of 2 single file rotary Ni-Ti systems with different designs and machined in a different way; first "One shape file" and the "Neolix file". The tip size 25 instrument was chosen for the analysis because it was the most common used to complete the preparation at apical stop or in all the extension of the root canal therefore undergoes both torsional and flexural loads [14].Researchers found that binding is likely to occur at the tip and most of the fractures and distortions occurred with sizes 20 and 25.In the other hand, the bigger diameter and taper core of the file the more resistant to torsional stresses[15]

However, other studies have contradicted this demonstrating that larger, stiffer files exhibited the greatest rate of fracture [25]

First permanent extracted molar gave the study greater reliability being more similar to clinical condition and most of the complications occurred in the molars[26] Selection of mesial root canals so that the two files exposed to the same conditions avoiding variations in canal curvatures which may cause error in the results, At working length 16mm after reducing the crown because the mesial canals used to be in the range between 16-24 mm so make more standardization [27] .

Most manufacturers recommend a crown-down approach of instrumentation reduce frictional

stresses on the instruments [28] and less vertical force & torque were created so instrument tips [29] Using pecking or pumping movement when manipulating rotary instruments decrease apical force and binding so prevent cyclic fatigue and instrument fracture[30]. Single experienced operator performed all the preparations to avoid inter operator variability.

Apical third of the files was selected for evaluation because clinically most instruments fractured within 1 to 3 mm from the tip because it considered the weakest part of the file .The most important factor to resist torsional stress is the file diameter [12]

The method chosen for evaluation of instrument was SEM. It considered being reliable and effective for accurate evaluation of instrument deformation, geometry of the cutting edges and modes of failure which is not possible by other conventional techniques. In addition, high resolution and magnification [31]. The quantification using computerized software provides accurate, reliable and non-subjective evaluation rather than the traditional scoring system. Presence or absence of eight defects was checked on the file surfaces according to (Tripi TR et al.2001) [11]. The only problem in SEM was it provides 2D topographic images of samples, making quantitative examination impossible.

NO Stereomicroscope because it provides a complete overview of the file rather than selected areas. Also, no Visual inspection with naked eyes because defects initiate microscopically within the elastic limit [15]

In this study Scanning the new unused file systems before using showed presence of Pitting, Fretting and Metal flashes with different incident rate [11] stated that manufacturing process of Ni-Ti usually results in distortions in the lattice structure of the alloy, variations in the micro hardness of the metal, machining and milling marks metal strips and micro cracks on their surfaces[32] also Debris due to adherent layer probably occurred from decomposition and oxidation of the lubricating oil used in machining the instruments[11] observed that no new Ni-Ti instrument was free from imperfections and Most of the new instruments presented from 2 to 7 types of surface defects. On the other hand [5] did not visualize changes in the file surface until they had been used several times.

Examination of the used One shape files under low and high torque after they have been cleaned in "digital ultrasonic cleaner" to remove any debris and clearly show the surface of the files showed that there was no statistically significant difference between them in terms of all defects. This may be due to the One shape file were electro polished and this caused a reduction in surface irregularities so not too much significant [33]

Examination of used Neolix files under low and high torque showed that there was no statistically significant difference between them in terms of all defects. This may be due to low torque was 2 Ncm and high was 4 Ncm so there wasn't a big difference between them, but there is not enough evidence to prove these relationships.

When comparing One shape to Neolix under low torque 2N/cm showed that there was no statistically significant difference between them in terms of all defects due to proximity of the core size in both files except Disruption of cutting edge which was higher in Neolix files. This might be due to difference in file design where the Neoniti had a negative rake angle. Or may be due to the quality and safe cutting edge of One shape file, antis crew in effect varying taper, wave like design decrease the plastic deformation to occur also the surface polishing layer prolong the fatigue life.

When comparing One shape to Neolix under high torque 4 N/cm showed that there was no statistically significant difference between them in terms of all defects except metal flash which was less in Neolix files. Indicating the work hardening of the metal and showing the surface modifications [11] That may be due to the Neolix files was manufactured by Electric

Discharge Machining process which gives it more finished surface so detached of the unsupported flashes during friction with the dentinal walls. On the other hand, may be due to high torque in One shape file made wear to the electro polished layer, and it just for a limited time so more metal flashes found on the surface.

Within the limitations of the present study. Results proved even the new files suffered from surface defects because manufacturing procedures were far from ideal and refers that quality of the manufacturing processor better physical properties not only number of uses. No used instruments free of surface defects even under high or low torque. Different torques cause statistically significant difference between One shape and Neolix files in terms of disruption of cutting edge and metal flash only.

Go in line with results from previous studies on different rotary Ni-Ti systems, investigated that torque and file design may increase the development of some microscopic surface defects [11]

The findings of our study suggest that although all files are predisposed to wear and fatigue, small files should have improved quality control by the manufacturer as they are highly prone to failure especially in curved canals or in high torque or multiple uses. Clinicians should be aware of the wear and tear occurring on the cutting surfaces of the nickel titanium instruments particularly used in rotary techniques and discarded after short time of use.

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