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Surface Defects of Used Reciproc and Reciproc Blue Rotary Nickel-Titanium Files (In Vitro Study)

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Abstract

Aim: to Evaluate Surface defects in new reciproc and reciproc blue rotary nickel-titanium files after thee and six canals preparation using Scanning Electron Microscopy.

Methodology: Sixty human mandibular molars were selected for the study, with moderate angle of curvature between (25o-35o). Mesial canals of the sixty molars were classified according to the file used for canal preparation into two groups. Group I: 60 MB canals were prepared using 10 Reciproc files. Group II: 60 ML canals were prepared using 10 Reciproc blue files. Each group divided into two subgroups A & B. in each group, these 10 files were used to prepare 30 canals so that each file was used to prepare 3canals (subgroub A). Then the same 10 files were further used to perpare another 30 canals ending up that each file was used to prepare 6 canals (subgroup B). Scanning Electron Microscopy was used to evaluate surface defects before and after three and six canals preparation.

Results: There was no statistically significant difference between reciproc and reciproc blue. In reciproc blue There was a significant difference between new and after three and six canals used in disruption of cutting edge, debris and scraping.

Conclusions: Different surface defects appeared to be present in all reciproc and reciproc blue new files with various incidence rates. By use for three and six times, reciproc blue files presented increased disruption of cutting edge, debris and scraping.

Keywords Reciproc, Reciproc blue, Surface defects.

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Introduction

The main objective of root canal treatment is bacterial eradication through mechanical preparation and canal disinfection. Traditionally, endodontic instruments were made of either carbon steel alloy or stainless steel alloy or Nickel-Titanium.

The Nickel-Titanium alloy "Ni-Ti" offered many advantages over these conventional files like super elasticity, shape memory, and lower modulus of elasticity. That gives better shaping and less straightening of the canals. Despite of their time saving and ease of use,(1) They are still prone to failure; plastic deformations or even fracture. Different generations of rotary Ni-Ti have been introduced in endodontic practice hoping to improve the fracture resistance and cutting efficiency of these files. These generations involve improvement in design features, metallurgical properties, and different motions.

It is necessary to observe the surface changes of Ni-Ti rotary instruments as it is considered an important factor in the failure or fracture initiation(2, 3). Fracture of Ni-Ti instruments could occur with little or no visible evidence of plastic deformation; that could not be visualized without magnification.(4, 5) As a consequence, the predictable way to avoid failure is to discard rotary files regularly after a number of uses, particularly in complex canal preparations. Recently introduced, Reciproc file is a nickel-titanium system introduced by VDM in 2011, characterized by S shape cross-section, non-working tip and has a variable taper, used in reciprocation motion. Reciproc is produced with M-Wire nickel-titanium that goes through an innovative thermal treatment. (6)

Reciproc blue files are a nickel-titanium system introduced by VDM in 2016 characterized by S shape cross-section non-working tip and has a variable taper. They are operated at reciprocation motion. They are single files. RECIPROC blue files have undergone an innovative heat treatment, modifying its molecular structure and resulting in a thin blue titanium oxide layer on their surface. (7) The aim of this study was to evaluate the surface changes of new Reciproc and Reciproc blue files and after three and six canals preparation, using Scanning Electron Microscope "SEM".

Materials and Methods:

Samples selection and preparation:

Sixty human permanent mandibular molars with mature apices and having moderate curvature (25o -35o) were selected for this study. Radiographs were taken to determine degree of curvature according to Scheinder's method. Access cavities were prepared and the root canals were negotiated using #10 K-file (Mani, Inc, Tochigi, Japan). Occlusal surfaces were flattened to have a comparable 16 mm length for all teeth.

Sample classification

Mesial canals of the sixty molars were classified according to the file used for canal preparation into:-

Group I: 60 MB canals were prepared using 10 Reciproc files.

Group II: 60 ML canals were prepared using 10 Reciproc blue files.

Classification of each group into two subgroups A & B:

First: in each group, these 10 files were used to prepare 30 canals so that each file was used to prepare 3canals (subgroup A). Then the same 10 files were further used to prepare another 30 canals ending up that each file was used to prepare 6 canals (subgroup B).

Subgroup A: 30 canals (3 canals each file).

Subgroup B: 30 canals (6 canals each file).

Scanning Electron Microscope (SEM):

All instruments were observed under scanning electron microscopy (sem; XL 20

Philips, Eindnoven, the Netherlands) before use and after preparing three and six root canals. custom-made holders were constructed for repositioning and photographing the sample. Samples were inspected (lateral view and top view) under SEM at magnification 300X and 1000X for their surface defects.

SEM examination for all files were done and inspected for the presence or absence of the following defects(8,9):-

Defect	Definition
Metallic strips	Visible flashes of metal protruding irregularly from the surface
Disruption of cutting edge	The loss of the regular continuous shape of the blades
fracture	Complete separation of parts
pitting	Small, excavated, punched out areas on a. surface
crack	Break down without complete separation of parts
fretting	Observable corrosion with friable surface texture
debris	Small particles made of materials removed from the canal
Scraping	Removed areas from a surface which may be due to excessive frictional force

Results:

Results showed that the surfaces of the new Reciproc and Reciproc Blue files had few defects before use as some metal strips, disruption of cutting edge, debris and pitting. After use, both file groups had defects on their surfaces, tips and blades. The frequency with which these defects were detected is detailed in Table 1. Figure (1).

Examination of each system new and after use three and six canals showed that there was no statistically significant difference between them in terms of all defects. Except in reciproc blue, There was a significant difference between new and after three and six canals used in disruption of cutting edge, debris and scraping.

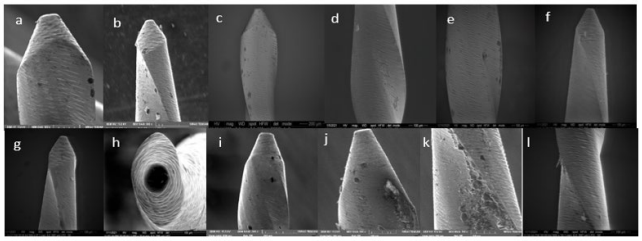

Figure (1): a) New Reciproc file showing: debris and Metal flash.b) New Reciproc file showing: pitting, fritting, debris and blunted of cutting edge. c) New Reciproc file showing: debris, cracks and Metal strip.d) Reciproc file after 3 canals preparation showing: cracks. e) Reciproc file after 3 canals preparation showing: Pitting and Debris and Scraping. f) Reciproc file after 6 canal preparations showing: Pitting, Scraping and Blunted of cutting edge. g) Reciproc file after 6 canal preparations showing: Blunt of cutting edge, pitting, fritting and Debris. h) New Reciproc blue file (top view. i) New Reciproc blue file showing: Metal strip, Debris and Pitting. j) Reciproc blue file after 3 canal preparation showing: Pitting, Metallic strips, Fritting and Debris. k) Reciproc blue file after 3 canal preparation showing: Pitting, fritting, Blunted of cutting edge and Debris.l) Reciproc blue file after 6 canal preparation showing: Metallic strips, Blunted of cutting edge, Debris.

Table (1): Frequencies (n) and percentages (%) of intragroup comparisons in Reciproc files

Defect		Reciproc files				Reciproc blue files			
		New files	After 3 times	After 6 times	P-value	New files	After 3 times	After 6 times	P-value
Metallic strips	n	6	6	6	1.000	6	6	6	1.000
	%	60.0%	60.0%	60.0%		60.0%	60.0%	60.0%	
Disruption of cutting edge	n	4	4	8	0.117	4^{B}	6^{AB}	10^{A}	0.015*
	%	40.0%	40.0%	80.0%		40.0%	60.0%	100%	
Fracture	n	0	0	0	NA	0	0	0	NA
	%	0%	0%	0%		0%	0%	0%	
Pitting	n	6	8	8	0.506	8	8	10	0.315
	%	60.0%	80.0%	80.0%		80.0%	80.0%	100%	
Crack	n	2	2	4	0.506	0	2	4	0.082
	%	20.0%	20.0%	40.0%		0.0%	20.0%	40.0%	
Fretting	n	2	2	4	0.506	0	4	4	0.065
	%	20.0%	20.0%	40.0%		0.0%	40.0%	40.0%	
Debris	n	6	8	10	0.082	4^{B}	8^{AB}	10^{A}	0.008*
	%	60.0%	80.0%	100%		40.0%	80.0%	100%	
Scraping	n	0	4	4	0.065	0^{B}	2^{AB}	6^{A}	0.008*
	%	0.0%	40.0%	40.0%		0.0%	20.0%	60.0%	

Different superscript letters indicate a statistically significant difference within the same horizontal row*; significant ($p \leq 0.05$).

Discussion:

The aim of this study was to observe superficial defects in Reciproc and Reciproc blue files before and after the instrumentation of root canals.

It was possible to determine when alterations appeared on the files and what types of changes were observed after each use in both types of instruments evaluated. Scanning electron microscope was chosen as the method for the evaluation of superficial defects before and after each use. This method has been used in other studies (10, 11, 12) and has been accepted for the accurate evaluation of deformation of instruments (13).

The SEM evaluation of the instruments after each usage revealed the presence of marks and pits from the manufacturing process, consistent with previous reports (12,14,15).

When comparing Reciproc to Reciproc Blue new, after three and six times in terms of all defects, it was observed that there was no statistically significant difference between them, Except in reciproc blue There was a significant difference between new and after three and six canal used in disruption of cutting edge, debris and scraping.

It is important to point out that the presence of imperfections found in new instruments may contribute to the deterioration of the instrument or lead to larger defects. The improvement of surface finishing of these instruments could reduce deterioration in clinical use.

Conclusion:

Different surface defects appeared to be present in all reciproc and reciproc blue new files with various incidence rates. By use for three and six times, reciproc blue files presented increased disruption of cutting edge, debris and scraping.

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