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Effect of 4 Different Irrigation Media on Cyclic Fatigue of 2 Different Files in Double Curved Simulated Canal

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ABSTRACT

Background: Ni Ti mechanical properties is of great importance that give the files its flexibility and grant us a more convenience preparation in curved and double curved canals. Instrument separation during canal preparation is a common incidence, and a cyclic fatigue (metal fatigue) is a common reason.

The aim of this study: is to compare the impact of 4 different irritant conditions on the cyclic fatigue of 2 kinds of NiTi instrument: forty One curve rotary files (taper 0.06, 0.25 tip size) (Micro Mega, France), forty Reciproc blue rotary files (taper 0.08, 0.25 tip size) (VDW, Munich, Germany), in a custom made double curved stainless steel artificial canal.

Materials and Methods: eighty NiTi files are included in this analysis and divided into four subgroups for each main group A: Sodium hypochlorite 5.25% Group B: chlorhexidine gluconate 2% Group C: Distilled water Group D: without irrigant Each group subdivided into four subgroups each group (n=10) used in double curved canal.

A torque-controlled handpiece was operated with all instruments and mounted on surveyor with special tool for standardization and were utilized according manufacturer instruction and exposed to cyclic fatigue testing until instrument fracture happens.

The time for fracture was recorded, and then the cycles number was recorded. one-way ANOVA is utilized to analyze the data statistically, among groups. Post hoc tukey test to select the significance of results.

Result: For all groups, the best cyclic fatigue resistance was seen with chlorhexidine digluconate ($p \leq 0.05$) followed by distilled water then sodium hypochlorite and without irrigant, respectively.

The resistance of one curve file to cyclic fatigue is smaller than that of reciproc blue files. conclusion for this study is firstly the best of the 4 irrigant conditions used in this study that showed increased resistance to cyclic fatigue is chlorhexidine gluconate 2% followed by distilled water and then sodium hypochlorite 5.25% and the least one is an empty canal (without irrigant) and the strongest file used in this study is Reciproc blue followed by One curve.

Key words: Simulated canal, Chlorhexidine digluconate, Distilled water, Fatigue.

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INTRODUCTION

A rotary endodontic instrument has fatigue life which can be explained with how much it is flexed when put in an angulated root canal. when the tip or some piece of the endodontic file is stuck inside a canal, a Torsional fracture happens while the instrument shaft keeps on rotating For this situation metal elastic limits are exceeded which lead to plastic deformation and ultimately to fracture [1].

Despite the fact that there has been significant improvement in instrument producing ways, configurations, and techniques of manufacture of NiTi endodontic rotary instruments, intracanal breakage brought about by cyclic fatigue has remained the most significant factor to concern particularly for sever curves in root canals. The mechanical execution of NiTi instruments are amazingly touchy to their thermomechanical treatment and microstructures. Consequently, one of numerous ways for boost the resistance of rotary instrument to cyclic fatigue is through

enhancing its microstructure of NiTi alloys through thermomechanical treatments or new assembling innovations [2].

One curve is a specially designed heat-treated rotary file made from NiTi that using a single instrument for shaping of the entire length of the canal, from top to the apex directly. It's a single file system (25\0.06).

Reciproc Blue File The cross-sectional pattern of the files has an S shaped with a progressive taper and two cutting blades only. It is present with R25, R40, R50.

The aim of this study is to see the effect of different irritant situation on two types of files in double curved artificial canal also showing the highest Ncf of the files used.

MATERIAL AND METHODS

For 80 rotary files, cyclic fatigue resistance was performed utilizing artificial canal (with double curvature) for testing which have canal width of 1.5 mm and a curvature radius for both canals was 5 mm in a block of stainless steel with a glass cover (custom made) that was permitting for rotating file direct visualization in the canal and permitting broken instruments discarding among tests [3] as shown in Figure 1.

Instruments divided into 2 main groups (n=40) and each one has 4 subgroups (n=10) with same materials for testing as following:

Group A: one curve #25\06.

Group B: Reciproc blue R25 #25\08 and subgroups:

Subgroup 1: Testing with sodium hypochlorite 5.25%.

Subgroup 2: With chlorhexidine digluconate 2%.

Subgroup 3: With distilled water.

Subgroup 4: Without any liquid.

Firstly, all the files under the x20 magnification were checked by Stereomicroscope (MEIJI Techno, Japan) and any file deformation contribute to file exclusion.

A handpiece specially designed for dental use (X Smart plus Electric motor) was mounted on a movable surveyor. This gave a better controlling of the handpiece movement, perfection, and simplicity of file placement inside of the artificial custom-made canal, securing three-dimensional placement, and for better file alignment to the selected length for standardization [4].

Each canal filled completely with testing solution and according to subgroup to be tested before file can be inserted to the wanted length within custom made canal to minimize generation of heat [5]. The starting button was pressed and file begin to rotate within the canal (without pecking motion) and the handpiece used (6:1 reduction handpiece) is being power supplied by a torque controlled motor device at the manufacturer advised speed [6,7]. To preclude any human mistake and to standardize this test, video recording was done at the same time for recording time of instrument failure [8]. Fracture happening while was dependent on instruments visual perception of the fracture. The fracture time (T) recorded in second (from beginning of the test until fracture happened).

RESULTS

Descriptive statistic (Mean, Standard deviation, Minimum, Maximum) was shown in the following Tables of each file separately, high mean gives us an idea to high cyclic fatigue resistance.

It is clear in Table 1 with different irrigating media that the highest mean of NCF represented by group A2 (chlohexidine digluconate) had 995.0000 followed by group A3 (distilled water) that was 904.0000 cycle followed by group A1 (sodium hypochlorite liquid)had 777.5000 cycle

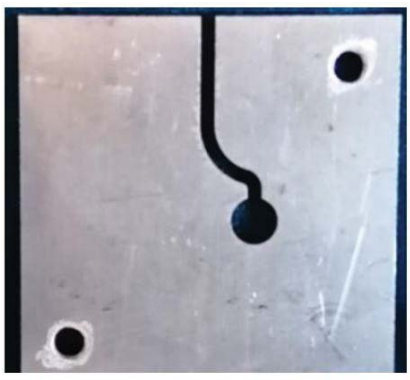

Figure 1: The stainless-steel simulated canal.

while the lowest mean of NCF represented by A4 (without irrigant) had 648.7000 cycle.

To see the statistical relation in the number of cycles to fracture for One curve instrument among the four groups ANOVA test was used (Table 2).

ANOVA table show that there was a significant difference in the number of fracture cycles among the different irrigating media p≤0.05 among One curve group.

Tukey HSD test was used as in Table 3, which shows that there was a significant difference in the number of fracture cycle between all the groups(p≤0.05).

It is clear in Table 4 with different irrigating media that the highest mean of NCF represented by group B2 (chlorhexidine digluconate) that was 1625.0000 cycle followed by group B3 (distilled water) had 1555.0000 followed by group B1 (Naocl liquid) had 1509.0000 cycle while the lowest mean of NCF represented by B4 (without irrigant) had 975.0000 cycle. To see the statistical relation in the number of cycles to fracture for Reciproc Blue instruments among the four groups ANOVA test was used (Table 5).

ANOVA table show that there was a significant difference in the number of fracture cycle among the different irrigating media p≤0.05 among Reciproc blue groups.

Tukey HSD test was used as in Table 6, which shows that there was a significant difference in the number of fracture cycle between all the groups (p≤0.05) except between sodium hypochlorite and chlorhexidine digluconate subgroups and also between sodium hypochlorite and distilled

Table 1: Descriptive statistical analysis for the (NCF) for each subgroup for One curve group.

Group	N	Min	Max	Mean	Sd
A1(NaoCl liquid)	10	710	850	777.5	47.39022
A2 (Chlorhexidine digluconate)	10	895	1070	995	49.44132
A3 (Distilled water)	10	860	950	904	32.8126
A4 (Without)	10	580	889	648.7	100.30958

Table 2: ANOVA test for the number of cycles to fracture for One curve instrument among groups.

	Sum of squares	d. f	Mean square	F	P-value	Sig.
Between Groups	619287.675	3	206429.225	48.577	0	S
Within Groups	152983.1	36	4249.531			
Total	772270.775	39				
p>0.05 non-significant, p ≤ 0.05 significant						

Table 3: Tukey HSD test for the (NCF) for one curve with different irrigating media.

Variable	Mean difference	P-value	Significance
A1-A2	-217.50000*	0	S
A1-A3	126.5	0	S
A1-A4	128.80000*	0	S
A2-A3	217.50000*	0	S
A2-A4	346.30000*	0	S
A3-A4	128.80000*	0	S
p>0.05 non-significant, p ≤ 0.05 significant			

Table 4: Descriptive statistical analysis for the (NCF) for each subgroup for Reciproc blue group.

Group	N	Min	Max	Mean	Sd
B1(Naocl liquid)	10	1205	1670	1509	148.91832
B2 (Chlorhexidine digluconate)	10	1420	1915	1625	154.75788
B3 (Distilled water)	10	1290	1805	1555	152.42484
B4 (Without)	10	785	1155	975	109.34146

Table 5: ANOVA test for the number of cycles to fracture for two shape instruments among groups.

	Sum of Squares	d. f	Mean Square	F	p-value	Sig.
Between Groups	4281207.5	3	1427069.167	94.797	0	S
Within Groups	541940	36	15053.889			
Total	4823147.5	39	-			
p>0.05 non-significant, p ≤ 0.05 significant						

Table 6: Tukey HSD test for the (NCF) for Reciproc blue with different irrigating media.

Variable	Mean difference	P-value	Significance
B1-B2	-116.00000-*	0.281	NS
B1-B3	-46.00000-*	0.888	NS
B1-B4	-534	0	S
B2-B3	70	0.693	NS
B2-B4	650.00000*	0	s
B3-B4	580.00000*	0	S
p>0.05 non-significant, p ≤ 0.05 significant			

water subgroups also between chlorhexidine gluconate and distilled water (p>0.05), it is non-significant.

DISCUSSION

The benefit of this study is to check the cyclic fatigue of 2 types of NiTi instrument have a various heat treatments and cross section that affected by a selected irrigant type in a static motion state in the stimulated canal.

In the case of fracture instrument (as a result of cyclic fatigue), that happens as a consequence of microcracks formation on the instrument surface due to its repeated loading, more specifically in the canal with a curvature opposite to the maximum of compression or tension in the curve height at particular point of the instrument [9]. Extracted teeth is the most extremely mimicking the natural clinical status, but, because the difficulty in similarity of two root canals or its not found identically in addition to objectives of most studies is to test the NiTi instruments physical performance purely [10].

Relevance of the results from these S.S. canals to the clinical situation should be done with great care because the difference between dentin and S.S.block [11].

With most clinical situations, double curves may be present at the same canal. Moreover, radiographic studies (for frequency of presence and degree of canal curvature) reveals that secondary curvatures founds in almost all canals [12].

Even irrigants utilized at room temperature because their effects in cyclic fatigue [13-15] and suggests that an environmental temperature have major impact on the cyclic fatigue resistance of NiTi instruments.

For intra group comparison for one curve and according to the results seen at Table 1, Highest Ncf mean for one curve was shown by chlorhexidine digluconate mean (995.0000) ± (49.44132) and this results may be due its continuous rotation motion and file fabricated by C-wire treatment (at canal temperature one curve is martensitic in phase) [16] and optimum taper and diameter and variable cross section all along the blade improved blade flexibility and (micromega) According to ANOVA test and Tukey HSD shows in the Tables 2 and 3, there a significant difference between all one curve groups (p≤0.05) and this is may be because the C-wire heat treatment which give a file a resistance for breakage and weakening according to irrigant used [16].

For intra group comparison for reciproc blue and according to the results seen at table 4, Highest Ncf mean for reciproc blue was shown by chlorhexidine digluconate mean (1625.0000) ± (154.75788) this is may be for its manufacturing from M-wire and its blue heat treatment in addition to (The reciprocating motion of the rotary instrument made from NiTi has offer a benefit to minimize the impact of cyclic fatigue and also has shown to prolong the lifespan, in comparison with continuous rotation) [17,18] that may to be affected by NaOCl and distilled water and least affect by Chlorhexidine. This result agrees with the other studies [18].

Reciproc blue instrument, ANOVA test and Tukey HSD test has a significant difference in the number of cycle to fracture between all the groups (p≤0.05) except between sodium hypochlorite and chlorhexidine digluconate subgroups and also between sodium hypochlorite and distilled water subgroups also between chlorhexidine digluconate and distilled water (p>0.05), it is non-significant. as shown in the Tables 5 and 6, which may be because its blue heat treatment which give a file a resistance for breakage and weakening according to irrigant used.

Form the above mentioned results , reciproc blue have a high resistance for cyclic fatigue than one curve file and may be because its manufacturing from M-wire and its blue heat treatment in addition to (The reciprocating motion of the rotary instrument made from NiTi has offer a benefit to minimize the impact of cyclic fatigue and also has shown to prolong the lifespan, in comparison with continuous rotation) [17,18] in addition to its high taper (08).

CONCLUSIONS

According to the conditions of this study, the conclusions that can be got are:

1. The best of the 4 irrigant conditions used in this study that showed increased resistance to cyclic fatigue is chlorhexidine gluconate 2% followed by distilled water and then sodium hypochlorite 5.25% and the least one is an empty canal (without irrigant).

2. The strongest file used in this study is Reciproc blue followed by One curve.

3. The reciprocation files is with more resistance to cyclic fatigue than continuous rotation files.

4. Increase canal curvature number or degree of curvature, is of great influence in decreasing cyclic fatigue resistance.

5. Metallurgy of file, taper. Flexibility and wire type have a great influence in the cyclic fatigue resistance.

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