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THE EFFECT OF AUTOCLAVE STERILIZATION ON CYCLIC FATIGUE RESISTANCE OF TWO NI-TI SYSTEMS (AN IN-VITRO STUDY)

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ABSTRACT

The aim of this study was to evaluate the effect of sterilization on the cyclic fatigue resistance of Reciproc Blue rotary files and One Curve rotary files.

Methods: For each test of the cyclic fatigue thirty files of each system were used. Ten of the thirty rotary files were used new, ten rotary files after three sterilization cycles and ten rotary files after six sterilization cycles. For cyclic fatigue testing a static model was used with a specific device, which allowed the instruments to rotate freely inside a Stainless-Steel artificial canal.

Results: The results showed higher cyclic fatigue of Reciproc Blue than One Curve with no effect of sterilization on Reciproc Blue and decreeing in the cyclic fatigue resistance for One Curve.

Conclusions: Reciproc Blue has higher cyclic fatigue resistance than One Curve. With no effect of sterilization on cyclic fatigue of some files while have negative effect on others.

KEYWORDS: Cyclic fatigue, Reciproc Blue, One Curve

INTRODUCTION

Properties of different files are affected by several factors, one of them is the repetitive autoclaving and sterilization of them which may affect their cutting efficiency, cyclic fatigue resistance and their surface roughness and dentinal debris accumulation on them.

Cutting efficiency is one of the properties of instruments which defined as the capability to remove dentine from canal. Several parameters such as angle incidence between instrument and root. cross-sectional design, rake and helical angles, hardness of the alloy, heat treatments and instrument motion influence the endodontic files cutting.

The use of NiTi files for root canal preparation has increased due to their unquestionably favourable qualities; however, unpredicted fracture is a drawback of these instruments. Fatigue fracture

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happens due to repetitive tensile and compressive stresses at the point of maximum flexure of an instrument rotating in a curved canal.

In recent years NITI rotary files like One Curve and NITI reciprocating files like Reciproc blue have altered root canal instrumentation.

One Curve is single-use rotary file that manufactured from heat-treated Nickel-Titanium alloy, enables shaping of the whole canal with a single instrument.

RECIPROC blue files are produced with NiTi which goes through an innovative treatment, modifying its molecular structure to give it increased resistance to additional flexibility and cyclic fatigue as well as its characteristic blue color.

So, this study was conducted to evaluate the effect of autoclave sterilization on RECIPROC blue and One Curve Ni-Ti instruments in terms of: Cyclic fatigue resistance of instruments.

MATERIAL AND METHODS:

Thirty (size 25, taper 6%) were selected for this study and were divided into 2 main groups:

- Group 1 (30 files) Reciproc blue
- Group 2 (30 files) One curve

Each group was sub-groped according to the method of evaluation into:

Subgroup 1 (10 files): New files without sterilization.

Subgroup 2 (10 files): After 3 cycles of sterilization.

Subgroup 3 (10 files): After 6 cycles of sterilization.

Cyclic fatigue

Instruments preparations

The instruments were subjected to 0, 3 & 6 cycles of autoclave sterilization consequently under following settings:

- Pressure: 15 psi with saturated steam
- Temperature: 131c
- Time: 15 minutes

Evaluation (Fig.1)

A custom-made cyclic fatigue-testing device used in the present study was specially designed and fabricated from aluminum. The simulated root canals with radius of curvature of 5 mm and an angle of curvature of 60° degrees fixed to the main part with two screws. Instruments were rotated till fracture. Each file was operated according to the manufacture instructions. To reduce file friction a multipurpose synthetic oil was added to the testing canal before each testing period.

Instruments fracture was visually and audibly detected, and the time to fracture was recorded with a digital stop watch accurate to 0.01 seconds.

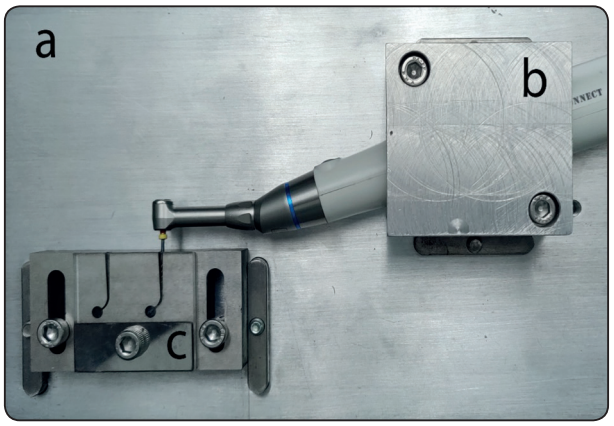

Fig. (1) Cyclic fatigue device showing: a: main frame, b: contra housing and endodontic contra inside, c: simulated artificial canal

RESULTS

Cyclic Fatigue Resistance

1- Effect of sterilization:

a) Reciproc Blue: (table1)

0 cycles showed 432.8 ±14.4 seconds to fracture.

3 cycles showed 438.27±2.01 seconds to fracture.

TABLE (1) Time to fracture means ± standard deviations (SD) of Reciproc Blue

Factor	Mean ± StDev
0 cycles	432.8 ±14.4 [a]
3 cycles	438.27 ±2.01 [a]
6 cycles	439.50 ±0.47 [a]

Means with the different letter within each raw are significantly different at p ≤ 0.05

6 cycles showed 439.50±0.47 seconds to fracture.

Sterilization showed no statistically significant effect on cyclic fatigue resistance of Reciproc Blue instruments.

b) One Curve: (Table2)

0 cycles showed 146.0 ±11.2 seconds to fracture.

3 cycles showed 120.16±1.73 seconds to fracture.

6 cycles showed 121.1 ±2.49 seconds to fracture.

Sterilization decreased the cyclic fatigue resistance of One Curve with no difference between three and six cycles of sterilization.

TABLE (2) Time to fracture means ± standard deviations (SD) of One Curve

Factor	Mean ± StDev
0 cycles	146.0 ±11.2 [b]
3 cycles	120.16 ±1.73 [b]
6 cycles	121.15 ±2.49 [b]

Means with the different letter within each raw are significantly different at p ≤ 0.05

2- Effect of file type: (Table3)

a- After 0 cycles of sterilization:

Reciproc Blue: 432.8 ±14.4 seconds to fracture.

One Curve: 146.0 ±11.2 seconds to fracture.

b- After 3 cycles of sterilization:

Reciproc Blue: 438.27 ±2.01 seconds to fracture.

One Curve: 120.16 ±1.73 seconds to fracture.

c- After 6 cycles of sterilization:

Reciproc Blue: 439.50±0.47 seconds to fracture.

One Curve: 121.15 ±2.49 seconds to fracture.

Reciproc Blue showed a higher cyclic fatigue resistance than One Curve for the three tested conditions.

TABLE (3) Time to fracture means ± standard deviations

	Reciproc Blue	One Curve	P value
0 cycle	432.8 ±14.4 [a]	146.0 ±11.2 [b]	0
3 cycles	438.27 ±2.01 [a]	120.16 ±1.73 [b]	0
6 cycles	439.50 ±0.47 [a]	121.15 ±2.49 [b]	0

Means with the different letter within each raw are significantly different at p ≤ 0.05

DISCUSSION

Reciprocating movement has been introduced principally to prevent screw in effect into root canals while it was also stated to affect cyclic fatigue resistance positively. So, in the present study we chose to evaluate One Curve which is a file manufactured by new heat treatment and RECIPROC blue which is a reciprocating instrument.

File separation is a major fear during endodontic instrumentation. Although multiple factors donate to file separation, cyclic fatigue has been shown as one of the leading causes[1].

In the present study, we used a simulated canal shape model to closely mimic the clinical situation. To provide the instrument with a suitable trajectory,

the canal machined to reproduce instrument size and taper. To allow the instrument to rotate freely inside the canal, the depth of the canal was milled to the maximum diameter of the instrument +0.2 mm. The Canal was milled from St-St to avoid wearing thus preserving the same trajectory for all files. A glass cover on top of St-St block is used to allow visualization of rotating instrument while preserving an accurate repeatable trajectory as glass has higher wear resistance than Ni-Ti files. As the canal curvature and angle can affect the cyclic fatigue resistance of rotary files[2,3]. The parameter of the simulated canal used in the present study drown by using the Pruett method to increase the similarity of all files trajectory inside it.

The cyclic fatigue resistance differs in aquatic medium than in air for the thermomechanically treated NiTi-controlled memory instruments as aqueous media may serve as a heat sink, also they decrease the friction of the instruments with the canal walls which would reduce the stresses on the instrument[4][5][6] [7][8]. In this context, a synthetic oil was used as a lubricant in the current study. Digital chronometer was used by the operator for time recording in most of the cyclic fatigue studies[9][10].

The results of this study showed higher cyclic fatigue resistance of Reciproc blue in all tested conditions. Which may be due to the blue heat treatment and the reciprocating motion as reported in other studies[11][12][13]. And no significant effect of autoclaving on cyclic fatigue resistance on Reciproc Blue which reported in other studies.[14][15]

CONCLUSIONS

Reciproc Blue has higher cyclic fatigue resistance than One Curve. With no effect of sterilization on cyclic fatigue of some files while have negative effect on others.

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