Available online at **www.ijmrhs.com**

ISSN No: 2319-5886

International Journal of Medical Research & Health Sciences, 2018, 7(1): 27-31

Evaluation of the Cyclic Fatigue of WaveOne Gold and Reciproc Blue using Different Irrigating Medium

Saif alislam Muhammad[1] and Hussain Al-Huwaizi[2]*

[1] *M.Sc. Student, Department of Conservative and Cosmetic Dentistry, College of Dentistry, University of Baghdad, Baghdad, Iraq*

[2] *Professor, Department of Conservative and Cosmetic Dentistry, College of Dentistry, University of Baghdad, Baghdad, Iraq*

**Corresponding e-mail: hussain@alhuwazi.net*

ABSTRACT

This study aimed to assess the resistance to cyclic fatigue of reciprocating nickel-titanium (NiTi) files (Wave One Gold and Reciproc Blue) and assess the effect of glyde and sodium hypochlorite 5.25% as a gel and liquid on it during testing. A total of 80 new WaveOne Gold primary and Reciproc Blue R25 were tested. The 40 files of the same brand were randomly assigned into four groups (n=8) and submitted to the irrigating protocol as follows: ***Group 1:*** *Testing without irrigating media,* ***Group 2:*** *Testing with glyde,* ***Group 3:*** *Testing with sodium hypochlorite 5.25% gel,* ***Group 4:*** *Testing with sodium hypochlorite 5.25% liquid,* ***Group 5:*** *testing with normal saline (control). The cyclic fatigue test was performed using the appropriate preset reciprocating mode ('RECIPROC ALL' or 'WAVEONE ALL') in a specially designed endodontic motor. Resistance to fracture was determined by recording the time. The instrument tested in stainless artificial canal with 60° angle of curvature and 5 mm radius of curvature. Resistance to cyclic fatigue of the same NiTi was affected by irrigating media. Reciproc Blue R25 was associated with a higher cyclic fatigue resistance in all groups compared to WaveOne Gold Primary. The study concluded that glyde, sodium hypochlorite 5.25% as a gel and as a liquid may reduce the resistance to cyclic fatigue of WaveOne Gold and Reciproc Blue significantly. However, the type of reciprocating instrument influenced cyclic fatigue resistance with Reciproc Blue R25 being more resistant than WaveOne Gold Primary.*

Keywords: Corrosion, Cyclic fatigue, M-wire, Nickel-Titanium, Reciprocating instruments, Sodium hypochlorite 5.25% Gel, Glyde

INTRODUCTION

Two types of fractures occur in the rotating endodontic instrument: fracture caused by flexural fatigue and fracture caused by torsion [1,2].

The cyclic fatigue resistance of NiTi rotary files has been tested by artificial canals with a lot of features, such as the radius and the angle of curvature, the location of the maximum curvature, and the type of artificial canals [3]. When the tip of the instrument or any other part of the instrument become blocked in the canal while the shank still rotates this is called torsional. Torsional fracture occurs when the torque of the hand piece exceeds the elastic limit of the metal [4].

Cyclic fatigue failure may occur without any previous singe of permanent deformation [5,6]. A lot of variable such as: metallurgic characterization of the NiTi alloy, surface treatment of the metal and operational speed may affect the fatigue resistance to fracture [7].

Corrosion that may occur in the NiTi files in the presence of sodium hypochlorite (NaOCl) solution may limit the resistance of the file to cyclic fracture [8]. Sodium hypochlorite have many advantages and disadvantaged, the use of NaOCl during root canal irrigation is the gold standard to dissolve the tissue and to disinfect the canal [9]. However, NaOCl can lead to several disadvantages as it can cause damage to the eye in a case of contact, bleach clothing, periapical tissue necrosis if it injected beyond the apical foramen and can cause corrosion of the surgical instrument

[10]. NiTi instrument come in contact with NaOCl during disinfection and during instrumentation when the canal and the pulp chamber was filled with NaOCl [11]. The corrosion pattern, involving the selective removal of nickel from the surface, can create micro pitting leading to weakening of the instruments [12].

There are many ways to improve the resistance of the file to fracture, reciprocating motion of the file, along with new alloy, and the manufacturing process [7].

WaveOne Gold (WOG; Dentsply Maillefer, Ballaigues, Switzerland) and Reciproc Blue (RPC Blue; VDW, Munich, Germany) were recently introduced to the market utilizing the single file single use with reciprocating motion. RPC Blue is the newest version of files known as Reciproc (RPC, VDW). As an RPC file, RPC Blue has a 2 cutting edges S-shaped cross section, with a non-cutting tip. The cyclic fatigue resistance of Reciproc Blue was two time higher than the cyclic fatigue resistance of Reciproc this is because the alteration in the molecular structure of the file by heat treatment, this treatment was also responsible for the blue color of the file [9].

WOG files are the new version of WaveOne files (Dentsply Maillefer). The dimensions, cross section, and geometry were altered but it maintained the reciprocation motion of files. The cross section of the file was modified to a parallelogram, having 2 cutting edges. Moreover, the off-center design used in ProTaper Next (PTN, Dentsply Maillefer) files is also used in WOG files. The files are manufactured using gold heat treatment. In contrast to M-Wire technology based on heat treatment before production, gold heat treatment is performed by heating and then slowly cooling the file after production. The manufacturer company claims that the new heat treatment increases the flexibility of files [10].

In a comprehensive literature review, no study examining the effect of glyde, sodium hypochlorite 5.25% as a gel and as a liquid on the cyclic fatigue resistance of Wave One Gold and Reciproc Blue during testing.

The null hypothesis tested that there are no differences in the cyclic fatigue resistance between the two instruments and there is no effect of the irrigating media on the cyclic fatigue resistance of the reciprocating file.

MATERIALS AND METHODS

Two brands of rotary instruments with tip size 25 were used: Wave One Gold (primary, size 25, 0.07 taper), Reciproc Blue (R25, 0.08 taper). Forty instruments for each type were tested within the artificial canal. The instruments were tested with different irrigating media. Ten groups were formed, eight instruments for each group as follows:

I. **Group A: Wave One Gold (primary) NiTi rotary instruments Tip size 0.25.**
   - **Group A-1:** Eight files of Wave One Gold (primary) without irrigating media.
   - **Group A-2**: Eight files of Wave One Gold (primary) with glyde.
   - **Group A-3:** Eight files of Wave One Gold (primary) with sodium hypochlorite 5.25% liquid.
   - **Group A-4:** Eight files of Wave One Gold (primary) with sodium hypochlorite 5.25% gel.
   - **Group A-5:** Eight files of Wave One Gold (primary) with normal saline.

II. **Group-B: Reciproc Blue (R25) NiTi rotary instruments Tip size 0.25.**
   - **Group B-1:** Eight files of Reciproc Blue (R25) without irrigating media.
   - **Group B-2:** Eight files of Reciproc Blue (R25) with glyde.
   - **Group B-3:** Eight files of Reciproc Blue (R25) with sodium hypochlorite 5.25% liquid.
   - **Group B-4:** Eight files of Reciproc Blue (R25) with sodium hypochlorite 5.25% gel.
   - **Group B-5:** Eight files of Reciproc Blue (R25) with normal saline.

Instrument of the groups of each brand were then subjected to cyclic fatigue testing device especially designed for the purpose that allowed a reproducible placement of the instruments in the canal [2].

The instrument does not bind in the canal, but it rotates freely in a curvature, generating tension/compression cycles at the point of maximum flexure until the fracture occurs. If an instrument is held in a static position and continues

to rotate, one-half of the instrument shafts on the outside of the curve is in tension, whilst the half of the shaft on the inside of the curve is in compression. This repeated tension/compression cycle, caused by rotation within curved canals, increases cyclic fatigue of the instrument [13].

Instruments were tested within the canal (60° angle of curvature) with radius of curvature for both canals was 5 mm and the width of canal was 1.5 mm within a block made from stainless steel with a swiveling glass cover allowed for visualization of the file rotating in the canal and the removal of broken instruments among tests [14]. All the instruments were activated with a Wave One endodontic motor (Dentsply Maillefer, Ballaigues, Switzerland) that was connected to the cyclic fatigue test device using the preset ‘‘Reciproc ALL’’ program designed specifically for Reciproc Blue R25 instruments and the ‘‘WaveOne ALL’’ program designed specifically for WaveOne Gold instruments. The instance of fracture was based on visual observation of the fracture occurring in the instrument. The time (T) of fracture recorded in second (from starting reciprocating within a canal until fracture occurred). Tukey's range test was used to compare the effect of irrigating media on the brand of the instruments used and independent t-test were used to compare the cyclic fatigue resistance of WaveOne Gold and Reciproc Blue in all groups.

RESULTS

Descriptive statistic for each file are summarized in Table 1. The mean of cycle to fracture of all Reciproc Blue groups was greater than the Wave One Gold groups ($p<0.000$). There was a significant difference among the five groups of the same brand when considering the irrigating media as the independent variable (one-way ANOVA $P=0.000$).

Table 1 Descriptive statistic for the for the cyclic fatigue resistance: TtF for each instrument in second ($p<0.000$)

Brand	Group	n	Mean	Standard Deviation	Min	Max
Wave One Gold	A-1	8	67.575	3.1249	63	72.6
	A-2	8	131.7	4.5469	125.4	138
	A-3	8	90.15	2.39464	86.4	93.6
	A-4	8	89.55	3.18703	85.8	95.4
	A-5	8	137.85	6.57854	127.8	147
Reciproc Blue	B-1	8	84.45	4.06624	78.6	90
	B-2	8	186.15	4.34741	180.6	195
	B-3	8	144.35	5.99023	130.2	149.4
	B-4	8	191.325	4.78323	186	197.4
	B-5	8	205.275	4.72916	199.2	214.2

DISCUSSION

Fracture of the rotating NiTi instrument was one of the most and common complication that occur during root canal preparation [15]. The aim of the manufacturers was to improve the cyclic fatigue resistance of NiTi rotary files by altering the design, metallurgy, and kinematics of the files and through the heat treatments applied to the files [16].

An artificial model was used in this study to standardize the conditions and to minimize the contributions of other mechanisms of failure (torsional) aside from cyclic fatigue. Although the extracted tooth model was more closely resembles the clinical situation, it was not an ideal model if the objective of study was to determine the pure physical properties of NiTi files, as no two root canals were perfectly identical [17].

From the result of the present study it's clear that the mean cycle to fracture decrease when we use sodium hypochlorite (5.25%) as a gel and liquid as compared with the control group (normal saline) and glyd. It has been reported that sodium hypochlorite has a more detrimental impact on the fatigue resistance of the NiTi instruments, as sodium hypochlorite appeared to have some influence on the crack initiation mode in the material [18]. The signs of surface corrosion indicate that NaOCl solution has an adverse influence on the fatigue behaviour of NiTi instruments [13,19,20].

On the other hand, the Group A-1 (without irrigate media) show the lowest mean cycle to fracture between the groups, this may be due to the friction and heat generation during testing that affect the cyclic fatigue of the tested instruments.

This result could be supported by another study concluded that the immersion of WaveOne Gold reciprocating instrument in NaOCl solutions decreased considerably their cyclic fatigue resistance [21]. But it is in contrast with the same study that says sodium hypochlorite reduces the cyclic fatigue of WaveOne Gold after immersion in normal saline during testing.

This result is in agreement with other report, concluded that cyclic fatigue resistance of WaveOne Gold reciprocating instrument was degreased after immersion in EDTA solutions [22,23].

The mean cycle to fracture for Reciproc blue decrease when we use sodium hypochlorite (5.25%) liquid as compared with the control group (normal saline).

No significant difference between the cyclic fatigue resistance of Reciproc blue with hypochlorite (5.25%) gel and glyde, these difference in the behavior between WaveOne Gold and Reciproc Blue are probably due to their difference cross sectional design [24].

Because no study examining the effect of irritant media on the cyclic fatigue of Reciproc Blue could be found in our comprehensive literature review, it is no possible to directly compare our result with other study. The present study was compare the cyclic fatigue resistance of Reciproc Blue R25 with that of WaveOne Gold Primary instruments. The null hypothesis was rejected because the cyclic fatigue resistance of the Reciproc Blue R25 instruments was significantly higher than that of WaveOne Gold Primary instruments. This study is in agreement with other report, concluded that cyclic fatigue resistance of The Reciproc Blue R25 instruments were significantly more resistant to cyclic fatigue than WaveOne Gold [25].

As a result, form thermo mechanical process Reciproc Blue was coated by an oxide layer. This thermal treatment of NiTi instruments show phase transformation changes that enhance the flexibility and cyclic fatigue resistance of the instruments [26]. A Gold wire was used to have WaveOne Gold primary using advanced metallurgy and heat treatment to increase the flexibility of the instrument.

The difference in the cross section between Wave One Gold and Reciproc Blue might also contribute to their cyclic fatigue resistance WaveOne Gold has a novel parallelogram-shaped cross section, whereas both Reciproc Blue and Reciproc have S-shaped cross sections There exists a lack of consensus on the effect of the cross-sectional shape of an instrument on its cyclic fatigue resistance, but several studies have indicated the dimension of the cross-sectional area as a more important factor in cyclic fatigue resistance than the alloy type [26,27].

CONCLUSION

Cyclic fatigue resistance of Reciproc Blue was higher than of WaveOne Gold. Glyde, sodium hypochlorite 5.25% as a gel and liquid may decrease the resistance of Reciproc Blue and WaveOne Gold to cyclic fracture.

DECLARATIONS

Conflict of Interest

The authors deny any conflicts of interest related to this study.

REFERENCES

[1] Serene, Thomas P., J. David Adams, and Ashok Saxena. *Nickel-titanium instruments: Applications in endodontics*. Ishiyaku EuroAmerica, 1995.

[2] Plotino, Gianluca, et al. "A review of cyclic fatigue testing of nickel-titanium rotary instruments." *Journal of Endodontics,* Vol. 35, No. 11, 2009, pp. 1469-76.

[3] Pruett, John P., David J. Clement, and David L. Carnes. "Cyclic fatigue testing of nickel-titanium endodontic instruments." *Journal of Endodontics,* Vol. 23, No. 2, 1997, pp. 77-85.

[4] Martin, B., et al. "Factors influencing the fracture of nickel-titanium rotary instruments." *International Endodontic Journal,* Vol. 36, No. 4, 2003, pp. 262-66.

[5] Peters, Ove A., and Fred Barbakow. "Dynamic torque and apical forces of ProFile. 04 rotary instruments during preparation of curved canals." *International Endodontic Journal,* Vol. 35, No. 4, 2002, pp. 379-89.

[6] Varela-Patiño, Purificación, et al. "Alternating versus continuous rotation: a comparative study of the effect on instrument life." *Journal of Endodontics,* Vol. 36, No. 1, 2010, pp. 157-59.

[7] Gambarini, Gianluca, et al. "Fatigue resistance of engine-driven rotary nickel-titanium instruments produced by new manufacturing methods." *Journal of Endodontics,* Vol. 34, No. 8, 2008, pp. 1003-05.

[8] Sonntag D and Heithecker K. "Korrosion von Nickel-Titan-Instruments." *Endodontie* Vol. 15, 2006, pp. 23-30.

[9] Zehnder, Matthias. "Root canal irrigants." *Journal of Endodontics,* Vol. 32, No. 5, 2006, pp. 389-98.

[10] Hülsmann, M., and W. Hahn. "Complications during root canal irrigation–literature review and case reports." *International Endodontic Journal,* Vol. 33, No. 3, 2000, pp. 186-93.

[11] Byström, Anders, and Göran Sundqvist. "Bacteriologic evaluation of the effect of 0.5 percent sodium hypochlorite in endodontic therapy." *Oral Surgery, Oral Medicine, Oral Pathology,* Vol. 55, No. 3, 1983, pp. 307-12.

[12] Yoshida, Satoshi, et al. "Characterization of a staurosporine-and temperature-sensitive mutant, STT1, of *Saccharomyces cerevisiae*: STT1 is allelic to PKC1." *Molecular and General Genetics MGG,* Vol. 231, No. 3, 1992, pp. 337-44.

[13] Peters, Ove A., and Frank Paqué. "Current developments in rotary root canal instrument technology and clinical use: A review." *Quintessence International,* Vol. 41, No. 6, 2010.

[14] Larsen, C. Michael, et al. "Cyclic fatigue analysis of a new generation of nickel titanium rotary instruments." *Journal of Endodontics,* Vol. 35, No. 3, 2009, pp. 401-03.

[15] Topçuoğlu, Hüseyin Sinan, et al. "*In vitro* comparison of cyclic fatigue resistance of ProTaper Next, HyFlex CM, OneShape, and ProTaper Universal instruments in a canal with a double curvature." *Journal of Endodontics,* Vol. 42, No. 6, 2016, pp. 969-71.

[16] Ferreira, F., et al. "Movement kinematics and cyclic fatigue of NiTi rotary instruments: a systematic review." *International Endodontic Journal,* Vol. 50, No. 2, 2017, pp. 143-52.

[17] Ye, Jia, and Yong Gao. "Metallurgical characterization of M-Wire nickel-titanium shape memory alloy used for endodontic rotary instruments during low-cycle fatigue." *Journal of Endodontics,* Vol. 38, No. 1, 2012, pp. 105-07.

[18] Condorelli, G.G., et al. "Improvement of the fatigue resistance of NiTi endodontic files by surface and bulk modifications." *International Endodontic Journal,* Vol. 43, No. 10, 2010, pp. 866-73.

[19] O'hoy, P.Y.Z., H.H. Messer, and J.E.A. Palamara. "The effect of cleaning procedures on fracture properties and corrosion of NiTi files." *International Endodontic Journal,* Vol. 36, No. 11, 2003, pp. 724-32.

[20] Berutti, E., et al. "Influence of sodium hypochlorite on fracture properties and corrosion of ProTaper Rotary instruments." *International Endodontic Journal,* Vol. 39, No. 9, 2006, pp. 693-99.

[21] El-Naghy, A.M., and S.E. Elsaka. "Effect of sodium hypochlorite and saline on cyclic fatigue resistance of WaveOne Gold and Reciproc reciprocating instruments." *International Endodontic Journal,* Vol. 50, No. 10, 2017, pp. 991-98.

[22] Ametrano, G., et al. "Effects of sodium hypochlorite and ethylenediaminetetraacetic acid on rotary nickel-titanium instruments evaluated using atomic force microscopy." *International Endodontic Journal,* Vol. 44, No. 3, 2011, pp. 203-09.

[23] Pedullà, Eugenio, et al. "Cyclic fatigue resistance of nickel-titanium instruments after immersion in irrigant solutions with or without surfactants." *Journal of Endodontics,* Vol. 40, No. 8, 2014, pp. 1245-49.

[24] Kim, Hyeon-Cheol, et al. "Cyclic fatigue and torsional resistance of two new nickel-titanium instruments used in reciprocation motion: Reciproc versus WaveOne." *Journal of Endodontics,* Vol. 38, No. 4, 2012, pp. 541-44.

[25] Keskin, Cangül, et al. "Cyclic Fatigue Resistance of Reciproc Blue, Reciproc, and WaveOne Gold Reciprocating Instruments." *Journal of Endodontics,* Vol. 43, No. 8, 2017, pp. 1360-63.

[26] Pirani, C., et al. "HyFlex EDM: Superficial features, metallurgical analysis and fatigue resistance of innovative electro discharge machined NiTi rotary instruments." *International Endodontic Journal,* Vol. 49, No. 5, 2016, pp. 483-93.

[27] Kaval, Mehmet Emin, Ismail Davut Capar, and Hüseyin Ertas. "Evaluation of the cyclic fatigue and torsional resistance of novel nickel-titanium rotary files with various alloy properties." *Journal of Endodontics,* Vol. 42, No. 12, 2016, pp. 1840-43.