The Effect of Multiple Glass Beads Sterilization Cycles on Cyclic Fatigue of AF Blue S One File

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Abstract

Introduction: Sterilization represent an important and essential aspect, now days Most of the dentists usually use the endodontic files for many times before they discard it, this could increase the need for reliable and fast sterilization method, but without affecting the physical properties of the endodontic files.

Aim of the Study: This study discusses an economic method of sterilization (glass bead) and its effect on the fracture resistance of the AF Blue S one file (Fanta) with multiple reuses of the system.

Method and Materials: A total of 75 AF BLUE S one NiTi Rotary files (FANTA) #25 size with 0.04 taper and 25 millimeter length, were used in this study, divided into three groups to test their cyclic fatigue resistance after multiple sterilization cycles.

Result: The results were statically analyzed using (SPSS) software, Anova test showed a statically high significant differences between the groups. Conclusions: Within the limitation of this study, it can be concluded that AF Blue S one file with 4 time glass bead sterilization cycle was the most fatigue resistant compared to zero and two sterilization cycle.

Keywords: *Sterilization, Glass Beads, Endodontic Files; Toxicity; sterilization.*

Introduction

Sterilization represent an important and essential aspect and it is a cornerstone in controlling the infection that could easily spread by various instruments which are used in the dental field.(1)

Dentists depends on files in performing root canal treatments, these files come in direct contact with the blood of the patient which can easily spread dangerous diseases like "AIDS and Hepatitis". Most of the dentists usually use the endodontic files for many times before they discard it, this could increase the need for reliable and fast sterilization method, but without affecting the physical properties of the endodontic files.(2,3)

Wet sterilization as autoclave and dry sterilization as the oven and glass bead sterilizer are the mostly used by the dentists,(4) unfortunately autoclave causes dullness and decrease the sharpness and cutting efficiency of the endodontic files, on the other hand dry heat oven needs time that is long to perform sterilization "sixty minutes at 180ºC", while glass bead sterilization is a variation of dry heat oven, needs only short time.(5,6)

Nickle Titanium (NiTi) files are appropriate instruments used for negotiation of the canals specially curved canals, The use of these files offers the reliability and possibility to provide a predictable root canal preparation, unfortunately these files are vulnerable to fracture.(7)

Many new NiTi files have been marketed by manufactures with the aim to offer safer and more

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effective file system.[8] The thermomechanical treatment of NiTi alloy resulting in enhancement of the physical properties by changing the crystalline structure of the alloy, reducing the frequency of file fracture.[9]

Repeated and prolonged usage of endodontic file has a negative effect on its physical properties which can lead to fracture. Some reports showed that the majority of file' s separation was due to cyclic fatigue. These files are used for many times by the dentists undergoing repeated cycles of sterilization.[10]

This study discusses an economic method of sterilization (glass bead) and its effect on the fracture resistance of the AF Blue S one file (Fanta) with multiple reuses of the system.

Method and Materials

A total of 75 AF BLUE S one NiTi Rotary files (FANTA) #25 size with 0.04 taper and 25 millimeter length, were used in this study, divided into three groups to test their cyclic fatigue resistance after multiple sterilization cycles:

Group 1: 25 files undergo no sterilization (control).

Group 2: 25 files undergo two cycles of sterilization with ten minutes intervals.

Group 3: 25 files undergo four cycles of sterilization with ten minutes intervals.

Files sterilization was done using glass beads sterilizer for 15 seconds at 425-475 ºF (218-246 ºC).[11]

In this study cyclic fatigue test has been done in custom made tapered stainless-steel artificial canals with regular (5 mm) radius and angles of curvature (90□),due to the limitation of obtaining standard result on using natural teeth associated with the wide variety of canal shape.[12]The block has been designed according to the dimensions of the files which aimed to check out,Test was carried out in according to the manufacture recommended speed of rotary system (375) Rpm, with 2.6 N torques manipulate setting. The middle of the simulated curvature used to be (5-7) mm from the tip of the file which has been positionedat full working length (19 mm). The whole files have been new and the working section is 25 mm in length. Cyclic fatigue tested used to be conducted with the file rotating freely inside the tapered artificial canal which result in that reproducible simulation of the file restrained in the artificial curved canal.[13,14]

The dental hand-piece has been mounted on wooden block that allowed manipulate of the hand-piece movement, and easy placement of every file inside the artificial canal, making sure 3-dimensional alignment and positioning the file to the identicaldepth for standardization. The artificial canal has been covered with transparent plastic sheet to forestall the files from slipping out and to enable the researcher observe the files while it works and when fracture has been occurs, so fracture was detectable due to the fact the files have been seen through the transparent plastic sheet window.[13,14]

Stainless Steel block was once constant to the wooden block to forestall its movement and to make the relation between the steel block and the hand-piece almost constant.[15] glycerin has been stuffed totally to inside the artificial canal, earlier than each file to the exacted size (19 mm) inside a canal in order to minimize friction and heat generation.[16] The files have been activated inside the canals by usage of (ENDOMAX PLUS) cordless endodontic hand-piece.

Video recording has been carried out simultaneously for more accurate work and to eliminate human error.[16] This equation describe the (NCF) for every file.

"Number of cycles to failure NCF = Speed RPM X Time (T) to fracture in minute"

The armamentarium used in this study are showed by (fig.1)

Fig: Instruments used to perform the study.

Results

The means and standard deviations of (NCF) for the three groups are shown in (Table 1). The results were statically analyzed using (SPSS) software, Anova test showed a statically high significant differences between the groups ($P < 0.001$).

Intra group comparison using least significant difference test also showed a statically high significant differences between the means of the three groups (Table 2).

Table 1 : The means and standard deviation of Number of Cycles to Fracture

Groups	No. of Files	Mean	SD	P
Group 1 (No Sterilization)	25	585.2	20.79	0.001
Group 2 (Two Cycles of Sterilization)	25	966.3	23.78	
Group 1 (Four Cycles Sterilization)	25	1058.2	20.45	

Table 2 : The Least Significant Difference Test between groups

Groups	P
Group 1 V Group 2	0.001
Group 2 V Group 3	
Group 1 V Group 3	

Discussion

The control of infection that is spreading by various tools used in dentistry is of great importance as a preventive measure for cross infection.

During procedure of root canal treatment the endodontic files come in direct contact with pulp tissue, oral fluids blood and saliva, these files could be considered " reusable sharps " making there sterilization as a must mandatory step.[17]several sterilization techniques utilized such as autoclave,dry heat oven, ethylene oxide gas and also glass beads sterilizer which provide dry heat with shorter exposure time [18,19]

Ni-Ti endodontic files are always having the risk of separation because of cyclic fatigue or torsional stress,[20,21,22] To reduce or overcome this mechanical failure, many method have been applicated by manufacturers to improve the fatigue resistance of file like electro-polishing the surface of the fileeg: (RaCe), twisting instead of machiningeg: (TF), and geometric characteristics alteration such as asymmetric design (Revo-S).[10,23]

Today, thermal processing could be the main approach to develop the alloy metallurgy properties by affecting its transition temperatures and thus leading to alter the fatigue resistance.[24,25] Any Temperature changes will affect crystalline phases in NiTi alloy. These changes result in enhanced the file physical properties such as cutting efficacy has been increased and the fracture resistance also elevated.[26,27] However, sterilization in some studies has been showed that not necessarily effective on the cyclic fatigue of the files.[28]

The choosing of two or four cycle sterilization cycles in this study based on reports showed that NiTi file can be used to shape up to 10 curved root canals.[3, 29]

In this present study statistically significant increase in the life time of the AF Blue S one file with the increase in the number cycle of glass bead sterilization in comparison with the cyclic fatigue of the file with zero and two cycle of glass bead sterilization. This result may be related to the heat treatment of the alloy and the wire intermediate face. A modified phase composition because of the changing transformation temperatures is the essential difference between the conventional NiTi and the thermomechanically treated alloy. As the conventional NiTi alloy contains austenite,[30] while, the thermomechanically treated NiTi alloy moreover contains varying amounts of R□phase and martensite under clinical conditions[31,32,33]. These modifications are supposed to lead to extra flexible endodontic files with a superior resistance to fracture which mean decrease the stress on the file during negotiating the canal which lead to increase fracture resistance[34], so thermomechanical treatments represent a modern technique of developing new endodontic file with enhance mechanical properties.[35]

This result may be similar to research of de Melo et al[36] and Zhao et al[37] showed that sterilization increased the fatigue life of rotary Ni-Ti instruments through the increase in hardness and torsional resistance of the material, also Khalil and Natto[38]in their study shows that cyclic fatigue increase with the modern heat treated file and thus exactly what the present research concluded. The result of this study may be related to the wire of the AF One Blue S file and the AR phase heat treatment of Ni-Ti alloy, While several research had

been shows disagreement with the result of this study as Mize et al[39] and Hilt et al[40] Also, AbuMelha[41] and Alshwaimi[42], which suggested that increase the number of autoclave sterilization of rotary files reduced their cyclic fatigue resistance.

Conclusions

Within the limitation of this study, it can be concluded that AF Blue S one file with 4 time glass bead sterilization cycle was the most fatigue resistant compared to zero and two sterilization cycle and so multiple cycles have significant alterations in the cyclic fatigue resistance of rotary AF Blue S one files.

Recommendation: According to the result of the present study it's recommended to sterilize the NiTi files with glass bead before using them.

Ethical Clearance: The Research Ethical Committee at scientific research by ethical approval of both MOH and MOHSER in Iraq.

Conflict of Interest: Non

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