بسم الله الرحمن الرحيم

MONA MAGHRABY

شبكة المعلومات الجامعية

التوثيق الالكتروني والميكروفيلم

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جامعة عين شمس

التوثيق الإلكتروني والميكروفيلم

قسم

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Evaluation of cyclic fatigue of three different Rotary Nickel Titanium Systems at different temperatures

Thesis submitted to Faculty of Dentistry, Ain Shams University
In Partial fulfillment of the requirement for the master degree in Endodontics

By

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B.D.S. (Faculty of Dentistry, Ain Shams University, 2014)

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2021

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Dedication

This work is dedicated to…

My dear father and mother, my lovely wife, my brother and my friends who have been a constant source of emotional and moral support in every aspect of my life, this accomplishment would certainly not have existed without them.

Acknowledgments

All praise be to ALLAH the most gracious, the most merciful…

I would like to express my deepest gratitude to **Prof. Ahmed Abdel Rahman Hashem,** Professor and head of Endodontic department, Faculty of Dentistry, Ain Shams University for his kind guidance, sincerity, extraordinary supervision and unlimited support and help throughout my academic and clinical work.

I would also like to thank **Dr. Tarek Moustafa Abdel Aziz,** lecturer, Endodontic department, Faculty of Dentistry, Ain Shams University for his excellent advice, valuable stimulating guidance and help during this study, and meticulous revision throughout this work.

I am truly thankful for my dear friend **Mohamed Salah El Wakeel** for his assistance in this thesis and for providing his custom-made device for testing dynamic cyclic fatigue resistance.

I would like to thank all the staff members in department of endodontics, Ain Shams University for their continuous guidance and supervision.

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Root canal cleaning and shaping are important phases in endodontic therapy. The objectives of instrumentation include; debriding the root canal system, continuously tapering in a conical form and maintain the original shape and position of the apical foramen. Conventional instrumentation was performed by hand filing with stainless steel files. However, the stiffness of these files (which increases with increasing sizes) causes straightening of curved canals and results in apical enlargement, ledge formation, transportation of apical foramen and non-tapered hourglass shaped preparation are problems frequently observed after instrumentation.

Instrumentation/procedural errors such as canal transportation, zipping, elbowing, ledging, strip and root perforations and file breakage may occur during instrumentation. These procedural errors may increase the risk of endodontic treatment failure. The complicated root canal anatomy further aggravates the situation.

From the late 1980s, Nickel-titanium alloy (Ni-Ti) was introduced for the manufacture of endodontic files. Ni-Ti has two main characteristics: shape memory and super elasticity. Since then rotary nickel-titanium instrumentation has been developed and numerous types are commercially available.

NiTi instruments offer many advantages such as maintaining the original shape of root canal, as well as decreasing the possibilities of zipping, ledge formation, and perforation risk. It also increases the canal preparation quality and reduces the time of the endodontic sessions needed for the cleaning and shaping step. Unfortunately unpredictable fracture of NiTi rotary instruments, especially in curved root canals, is one of their most important disadvantages.

The fracture of NiTi files during clinical use is affected by many factors including file design, rotational speed and torque and the angle of curvature of the canal. The file fracture occurs through two different mechanisms: torsional fatigue and cyclic fatigue. When the torsional stress exceeds beyond the elastic limit of the file, it will plastically deform and then, if the stress is still maintained, it results in the fracture of the file. In cyclic fatigue, the file fractures because of repetitive compression and tension stresses at the maximum curvature point of canal.

To decrease the fracture incidence of NiTi rotary files, the manufacturers aim to improve resistance of the files using different alloys during production, applying various heat treatments and changing the design properties of files.

HyFlex EDM (HEDM; Coltene/Whaledent, Altstätten, Switzerland) is a new-generation NiTi file system still used in

continuous rotary motion. HEDM represents the evolution of the HyFlex CM (HCM; Coltene/Whaledent) that was the first file system manufactured using the controlled memory (CM) technology. Differently from the HCM, the HEDM files are produced with the CM alloy and using the electrical discharging machining (EDM) technology. Making use of electrical discharges, the file is shaped by melting and vaporizing the material with a non-contact production method.

As many GP dentists or even some endodontic specialists start to use this Chinese files as they are much cheaper and widely spread at the market. One of the most known files in the Egyptian market is the M-Pro (IMD) file system which have a convex triangular cross section with a CM heat treated NiTi alloy. Denjoy (dental co) are another well-known files with the CM heat treated technology, the files have a triangular cross-section with optimized guiding tip.

It is postulated that these different heat treatments and designs can significantly affect the in vitro resistance to cyclic fatigue of NiTi rotary instruments. That’s why, dynamic cyclic fatigue testing at different temperatures was employed in this study.

Cyclic fatigue:

Fracture of rotary NiTi instruments occurs in two different modes: due to torsional failure or cyclic fatigue. The total cyclic life of NiTi endodontic instruments can be divided into two stages: starting with crack initiation in which microcracks form and start to grow preferentially along specific crystallographic planes or grain boundaries followed by crack propagation until final fracture. Cyclic fatigue resistance is usually measured by the time until fracture occurs or by the number of cycles to fracture (NCF). The cyclic fatigue testing techniques are either static or dynamic:

Static cycle fatigue:

The static cyclic fatigue model is the most commonly used model for cyclic fatigue failure testing where both the canal and the instruments are fixed in their position. Although it does not resemble the clinical situation it is easier to keep the instruments in a precise trajectory and liability for procedural errors is lower.

Gambarini et al. [1] investigated the effect of new manufacturing method for rotary nickel titanium instruments on the cyclic fatigue resistance. This was evaluated by comparing instruments manufactured using the twisted method (TF), those using the M-wire alloy (GTX) and the traditional NiTi

manufactured by grinding process (K3). Tests were performed with a specific cyclic fatigue device that evaluated cycles to failure of rotary instruments inside curved artificial canals. Results indicated that size 25/0.06 TF instruments showed a significant increase in the mean number of cycles to failure when compared with K3 size 25/0.06. K3 instruments size 30/0.06 showed no significant increase in the mean number of cycles to failure when compared with GT series X instruments size 20/0.06. They concluded that the new manufacturing process (TF) produced nickel-titanium rotary files significantly more resistant to fatigue than instruments produced with the traditional NiTi grinding process. Instruments produced with M-wire (GTX) were not found to be more resistant to fatigue than instruments produced with the traditional NiTi grinding process.

Zhou et al [(2)] investigated the newly introduced files which are controlled memory (CM) nickel-titanium wires using x-ray energy dispersive spectroscopy and differential scanning calorimetry to evaluate the mechanical properties and the structure of those files . The mechanical properties of the wires at selected temperatures (room temperature, 37°C, and 60°C) were evaluated with tensile, cyclic tensile, and cantilever bending tests by using an Instron 3365 universal testing machine. Files made of CM wire showed superior