Cyclic Fatigue Of Two Different Rotary Nickel Titanium Instruments Used In Reciprocation Motion

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"بسم الله الرحمن الرحيم"

"رَبِّ أَوْزِعْنِي أَنْ أَشْكُرَ نِعْمَتَكَ الَّتِي أَنْعَمْتَ عَلَيَّ وَعَلَى وَالِدَيَّ وَأَنْ أَعْمَلَ صَالِحًا تَرْضَاهُ وَأَدْخِلْنِي بِرَحْمَتِكَ فِي عِبَادِكَ الصَّالِحِينَ"

صدق الله العظيم

Dedicated to

To my great Father , my precious Mother ,

my faithful wife Azza

And

To my lovely son Hamza ,my beautiful sisters

Sara,Nehal ,

And my dear freind

Thank you

For your time and enduring Me all the time.

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INTRODUCTION

Nickel titanium (NiTi) instruments are widely attractive among dentists because they enable more predictable preparation for root canals and significantly better treatment outcomes compared with stainless steel instruments. However, the potential for fracture of these instruments is still a main concern associated with their use.

Root canal curvature, instrument geometry, working speed, the use of irrigant, torque and sterilization procedures, metal surface treatments, heat treatment, metallurgic characterization of the NiTi alloys, and repeated clinical use are factors that might enhance instrument fatigue. Moreover, these factors can affect the life spans of different NiTi instrument systems.

Instrument fracture occurs as a result of torsional or flexural fatigue. **Torsional** fracture occurs when the torque resulted from the contact between the instrument and canal wall exceeds the torsional strength of the instrument, or when the instrument tip is locked in a canal whilst the rest continues to rotate. **Flexural** fatigue occurs by metal fatigue where the instrument rotates freely in a curvature, producing alternating tension-compression cycles at the greatest curvature until fracture.

Rotary NiTi instrument can be used in a continuous rotation or in reciprocation motion, Recently, a new concept for root canal preparation was introduced where only one instrument (single file) used in reciprocation movement. In this movement, the instrument rotates in counterclockwise (CCW) and clockwise (CW) directions, When the instrument rotates in the cutting direction, it will advance in the canal and engage dentin to cut it. When it

rotates in the opposite direction (smaller rotation), the instrument will be immediately disengaged. The end result, related to the degree of CW and CCW rotations, is an advancement of the instrument in the canal. This action reduces the cyclic fatigue and subsequent file fracture and requires less working time during root canal preparation phase. Studying the cyclic fatigue of instruments used in reciprocation motion is of great importance.

REVIEW OF LITERATURE

- **Continuous rotation versus reciprocation:**

Rotation is a circular movement of an object around a center or point of rotation. The greater tactile touch and efficiency gained when continuously rotating Ni-Ti files in smaller-diameter and more curved canals must be balanced with the inherent risks associated with torque and cyclic fatigue failures. Fortunately, these risks have been virtually eliminated due to continuous improvement in file designs, Ni-Ti alloy, and emphasis on sequential glide path management (GPM) [(1)] .

When an endodontic instrument rotates within its elastic limit inside a curved canal, The instrument does not bind in the canal but it rotates freely in a curvature, every bent portion is subjected to mechanical loading, which is represented by alternate compressive and tensile stresses ,i.e as an instrument is held in a static position and continues to rotate, one half of the instrument shaft on the outside of the curve is in tension, whilst the half of the shaft on the inside of the curve is in compression, at the point of maximum flexure until the fracture occurs (Pruett et al. 1997, Haikel et al. 1999) [(2)] .the magnitude of the tensile and compressive forces imposed on the flexed area of an instrument depends on the geometry of the curved canal (ie, radius length, arc length, and the position of the arc). The intensity of stress on the instrument increases as the curvature radius decreases, the arc length increases, and the arc is located in the coronal portion of the canal. [(3,4)] .

Continuous rotation utilizing well-designed active Ni-Ti files requires less inward pressure and improves hauling capacity augering debris out of a canal , compared to reciprocation [(5)]. However De-Deus et al .2010, showed that movement kinematics is a determining factor on cyclic fatigue of rotary NiTi instruments where the reciprocating movement is superior to conventional rotation .

The **reciprocating** motion can be described as an oscillating motion or repetitive back and forth motion or an alternating rotation where an instrument rotates in one direction and reverses direction before completing a full rotary cycle[(6)].

A reciprocating instrument travels a shorter angular distance than a rotary instrument, which subjects the instrument to lower stress values. Consequently, an instrument should have an extended fatigue life when used in reciprocation as opposed to rotary motion. The development of endodontic instruments used in a reciprocating manner aims to reduce the incidence of breakage. it mimics manual movement and reduces the various risks associated with continuously rotating a file through canal curvatures& decrease screw in the canal [(6)].

Watch winding

Is a reciprocating back and forth (clockwise / counterclockwise) rotation of the instrument in an arch. It is used to negotiate canals and to work files to place. Light apical pressure is applied to move the file deeper into the canal [(7)].

In **1985**, Roane et al introduced the **balanced force** technique using instruments in rotational reciprocation for the

preparation of curved root canals [8] .They were first report the use of hand files with unequal clockwise and counter-clockwise movements in reciprocation .The efficacy and the safety of this technique were questioned considering the relatively high incidence of procedural complication, such as instrument fracture and root perforation[9,10] .

However, numerous reports indicated good results were obtained with this technique for the preparation of curved canals without or with only minimal straightening , rekindling the interest in rotational reciprocation for canal preparation [8,11] .

Serendipitously, in about **1998**, Ben Johnson and Pierre Machtou co-discovered the unmistakable advantages, utilizing unequal bidirectional movements. This unequal bidirectional angles enhance augering debris out of the canal, which in turn, promotes the biological objectives for 3D disinfection and filling root canal system[12] .

However, current motors that drive reciprocating shaping files through equal forward and reverse angles generally require multifile sequences to adequately prepare a canal. Further, systems that utilize small, equal CW/CCW angles have recognized limitations, including decreased cutting efficiency, more required inward pressure, and a limited capacity to auger debris out of a canal [13] .

In **2008**, Yared [14] introduced a new concept for canal preparation .The canal preparation is accomplished using only one nickel-titanium engine-driven instrument **(single file)** used in