A Comparative Evaluation of two engine driven Nickel-Titanium files used in different kinematics

(An in vitro study)

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Dedication

This work is dedicated to…

My family who have been a constant source of emotional and moral support in every aspect of life, this thesis would certainly not have existed without them.

My professors, colleagues and friends from whom I have learned a lot and were always there when I needed help.

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LIST OF ABBREVIATIONS

Abbreviation	*Term*
NiTi	Nickel Titanium
St St	Stainless Steel
TFA	Twisted File Adaptive
VRF	Vertical root fracture
RSS	Root Surface Strain
RCL	Root Canal Length
CL	Canal Length
NaOCL	Sodium hypochlorite
AF	Apical foramen
ISO	Standardization of instruments
CEJ	Cementoenamel Junction
MB	Mesiobuccal
ML	Mesiolingual

Endodontic treatment aims primarily to retain the remaining tooth after being affected by decay or trauma in order to ensure the preserved structure and subsequent restoration are both functionally and esthetically surviving for the longest period of time in the oral cavity.

One of the main steps in achieving successful endodontic treatment is mechanical preparation of the root canal. This has to be done to achieve proper debridement of the root canal without changing the original shape of the root canal. Aberrant root canal anatomies makes proper debridement difficult and might lead to unwanted adverse events such as generation of excessive root surface strain, canal transportation, dentine microcracks with subsequent root fractures.

The incidence of such unfortunate events is high with using stainless steel files and hence the development of Nickel-Titanium (NiTi) files for a safer root canal preparation. Despite the use of highly flexible NiTi files in both rotary and reciprocating motions, dentinal defects after the instrumentation were inevitable indicating the deleterious root surface strain caused during instrumentation.

Recent advances made in these NiTi instruments with modifications in the file design, alloy or kinematics. This led to the development of files such as the Twisted File-Adaptive (TFA; SybronEndo, Orange, CA). The unique R-phase heat treatment and twisting of the metal in the TFA instruments improved their flexibility, strength and cyclic fatigue resistance. Furthermore the development of the innovative kinematics provided by the specialized motor (Elements Adaptive motor, SybronEndo) which switches between rotation and reciprocation motions depending on the intracanal stresses on the file during instrumentation to minimize dentinal defects. Also, the Reciproc (VDW, Munich, Germany) instruments have been specifically designed for use in reciprocation. Its non-cutting tip and M-Wire nickel-titanium alloy with the innovative thermal-treatment process offers increased cyclic fatigue resistance and greater flexibility than traditional nickel-titanium.

The aforementioned files are being compared regarding how the innovative file design, alloy and kinematics affect the amount of root strain during instrumentation, and in turn the correlation of the strain with the fracture resistance of the roots after root canal preparation, in simulated oral condition.

I- Root canal instrumentation using files with different kinematics:

Canal shaping is a crucial step in endodontic treatment. It creates the space needed for proper delivery of irrigants and placement of intracanal medicaments.[1] However, weakening of the tooth could occur during this step due to the stresses caused by the instruments especially in the apical third of the root which might lead to crack formation and eventually vertical root fracture.[2,3] Vertical root fracture is serious issue as it accounts as a major cause of extraction of endodontically treated teeth. [4,5] The use of rotary Nickel-Titanium instruments reduced the incidence of these unfortunate events but the development of stresses near the tip of these instruments were inevitable.[6]

Recent advances in these rotary NiTi instruments were directed to decrease these stresses through altering the file design, alloy used in manufacturing and the kinematics used. This has led to the development of files such as the Reciproc and the TF Adaptive files with special motors that provide them with the suitable kinematics.

A. Reciproc files

The concept of using a single nickel-titanium instrument to prepare the entire root canal was made possible due to the fact that a reciprocating motion is thought to reduce instrumentation stress. [7] Recent literature data show that reciprocating motion can extend cyclic fatigue resistance of nickel-titanium instruments when compared to continuous rotation, mainly because it reduces instrument stress. [8,9] As the instrument rotates in one direction (usually the larger angle), it cuts and becomes engaged into the canal, then disengages in the opposite direction (usually with the smaller angle); and the stresses are, therefore, reduced. [10] Following these concepts, new instruments have been recently commercialized such as Reciproc® (VDW, Germany) which uses specially developed motors that produce reciprocating movement (using approximately 150°-30° angles). This reduction of instrumentation stress (both torsional and bending stress) is the main advantage of reciprocating movement, even if it has been shown that a lot of different reciprocating movements can be used[11 12], each one affects the performance and the safety of the nickel-titanium instruments. Therefore, when discussing the advantages and disadvantages of reciprocation, the exact motion

should also be mentioned, since the actual angle of reciprocation can have a

substantial influence on both the clinical and experimental behavior of nickel titanium instruments. Another possible advantage of reciprocation is a better maintenance of the original canal trajectory, mainly related to lower instrumentation stress and, consequently, its elastic return. However, it must be underlined that reciprocation does not affect the inherent rigidity of the instruments. [13] However, there are also inherent disadvantages in reciprocating motion mainly the apical extrusion of debris. This is attributed to that the reciprocation movement is formed by a wider cutting angle and a smaller releasing angle, while rotating in the releasing angle, the flutes will not remove debris but push them apically[14,15]. Moreover, Reciproc techniques use a quite rigid, large single file of increased taper (usually 08 taper, size 25), which is directed to reach the apex[16]. In many cases, in order to reach the apical working length, reciprocating instruments are used with apically directed pressure, which produces an effective piston to propel debris through the patent apical foramen — and possibly directing debris laterally — making canal debridement more difficult[16]. One more disadvantage is that these instruments are commonly used without first performing preliminary coronal enlargement which may