Effect of Autoclaving on Cyclic Fatigue of HyFlex and ProFile Vortex Nickel Titanium Rotary Systems

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To my parents,

the real motive for finishing this work.

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Introduction

Instrument separation during root canal treatment is one of the common problems in endodontics. It has started with the introduction of canal shaping concept. In case of stainless steel instruments, fracture is proceeded by mechanical deformation as unwinding which warrants the operator to discontinue using the instrument[1]. Unfortunately, this is not the case of Nickel-Titanium (NiTi) files which could be fractured during function without any previous warnings even new files during their first use. This mechanical failure could be due to either overload or fatigue of the material[2,3].

Torsional overload occurs when part of the file is locked inside the canal while the over part continue to rotate under the motor torque surpassing the ultimate strength of the file[4]. In contrary, when a file is broken due to cyclic fatigue, all parts of the file rotate uniformly inside the canal undergoing forces which could be way below its elastic limit [5,6].

There is a continuous effort by scientists and manufacturers to prevent instruments fractures. Heat

treatment to improve the mechanical properties of NiTi alloys and prevent files fractures has been an area of much interest in recent years. This has introduced NiTi alloys with totally new properties.

M-wire and Controlled Memory wire (CM-wire) are among these new alloys. M-wire is claimed to have superior strength and more resistance to cyclic fatigue. It is characterized by being more flexible thus reducing the incidence of some procedural mishaps[7]. Profile Vortex is an example of files made of M-wire.

CM-wire is another product of NiTi heat treatments. It has been reported to have superior parameters especially its cyclic fatigue resistance, flexibility and controlled shape memory. HyFlex CM is among the files made of CM-wire.

Sterilization of files is essential for aseptic procedure in case of new files and to prevent cross infection if files to be used for more than on patient. Autoclaving of CM-wire files also act as heat treatment capable to revert some of the plastic deformation the file undergone during use and allow the file to regain its original shape[8]. However,

whether this would result in improved fatigue resistance is not understood. Therefore, examination of the effect of autoclaving on cyclic fatigue resistance of M-wire and CM-wire had been thought to be of value.

Review of Literature

This part of the study reviews the literature regarding modes of endodontic files separation, devices for fatigue testing of endodontic instruments and standardization of fatigue testing. It will also review some properties of heat treated NiTi files with emphasis on the effect of autoclaving on these properties.

The mechanical objectives of root canal preparation proposed by Schilder[9] advocated maintenance of the original canal path during shaping of root canals and outlined its impotence. This could be easily achieved if pulp spaces were regular straight spaces free of irregularities and aberrations. However, pulp spaces have been proven to be very complex systems[10,11,12] even when compared to the roots hosting them[9]. In order to maintain canal path, endodontic instruments are expected to be able to follow canal curvature and exert equal forces along their sides. Unfortunately, the properties of available materials would make endodontic files exert unequal forces on canal walls in curved canals; more force on outside of the curve