The Effect of Torque and Operator Force on the Failure of Protaper Ni-Ti Rotary Files

Thesis submitted to the
Faculty of Dentistry,
Ain Shams University
For
Partial Fulfillment of Requirements of the
Master Degree in Endodontics

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B.D.S. (Ain Shams University, 2003)

2012

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بسم الله الرحمن الرحيم

"وقال رب اوزعنى ان اشكر نعمتك التى انعمت على وعلى والدى وان اعمل صالحا ترضاه وادخلنى برحمتك فى عبادك الصالحين"

صدق الله العظيم
الآية19من سورةالنمل

Thank you

I would like to thank God for supporting and giving me the strength throughout all the years of studying.

I would also like to thank my parents for raising me and looking after me, my two brothers (Amr and Hossam) and my sister in law (Doha) for encouraging me all the time and for their continuous assistance. My special thanks are to dad, Amr and doha for assisting me in the computer work and photographing the files.

I would like to express my gratitude to Dr. Enas Fath El-Bab for giving me from her experience and for teaching me.

Acknowledgments

I would like to express my thanks and gratitude to Prof. Hossam Tewfik, Dean of faculty of dentistry and Professor of Endodontics, Faculty of Dentistry, Ain Shams University for his academic supervision, valuable advice, and assistance which made me able to do and finish this study, his immeasurable support which I will always remember and for revising the original manuscript. I would also like to thank him for allowing me to take some of his valuable time, showing me the academic way of thinking, organizing my thoughts and encouraging me to read a lot in my field to be broad-minded. I would also like to express my thanks to him for making me adore endodontics when he was teaching me endodontics during my undergraduate study. He made me get fascinated of how the endodontist fight the bacteria in the root canals aiming for complete recovery and healing of the periapical area. Finally I would like also to thank him for allowing me to borrow the X-Smart motor to do my practical work.

My sincere gratitude is to Dr. Shehab El-Din Saber, Associate professor of Endodontics, Endodontic Department, Faculty of Dentistry, Ain Shams University for his great assistance in supervising my research work, revising the original manuscript, downloading papers from J Endodod and for encouragement me all the time. His valuable guidance and encouragement gave me the spirit to complete my thesis.

I would like also to express my thanks to all the members of Endodontic Department for their cooperation.

Jasmine A.R. Moustafa

Dedication

To my Beloved Dad

My lovely Mum

My two sweet brothers

My Dear sister in-law

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Introduction: One of the major objectives for a successful endodontic therapy is the optimal cleaning and shaping of the root canal system. This is considered a decisive link because shaping determines the efficiency of subsequent procedures. It includes removal of infected soft and hard tissues, mechanical debridement, creation of space for the delivery of medicaments and creation of optimized canal geometries for adequate obturation[(1)].

For the process of cleaning and shaping, we use a variety of instruments, either hand-driven or engine-driven. These instruments are made of Carbon Steel, Stainless Steel or Nickel-Titanium.

The introduction of Ni-Ti rotary instruments had reduced the incidence of several clinical problems, such as ledges, perforation and transportation. Despite these advantages, they are still prone to failure depending on many interacting variables. This failure could be either torsional failure or due to cyclic fatigue. Torsional failure occur when the tip or any part of the rotating instrument binds to the root canal walls while the rest of the file keeps turning. This type of failure is associated with excessive apical force during instrumentation. It occurs with smaller-size files [(2)]. While cyclic fatigue occurs due to repeated flexure around canal curvatures leading to work hardening and metal fatigue. It occurs at the point of maximum flexure when the instrument is freely rotating in curved canal [(3)]. Cyclic fatigue most commonly occurs with large files sizes, indicating that larger instruments have fewer cycles before failure occur.

There are many factors that predispose to failure of rotary nickel-titanium instruments, among them is the torque used and operator force employed during cleaning and shaping. Therefore conducting a study to evaluate the effect of torque and operator force and the interaction

between them on the failure of rotary nickel titanium instruments was thought to be of value.

Review of Literature:

1- Incidence of failure of rotary Ni-Ti instruments:

Ankrum et al. 2004[5] investigated the incidence of file breakage and distortion when the Protaper, K3 Endo, and ProFile systems were used to instrument canals in the severely curved roots of extracted molars. Forty-five roots of extracted mandibular and maxillary molars with curvatures between 40 and 75 degrees were chosen for this study. Every 15 canals were instrumented with either ProFile system (group 1), Protaper system (group 2) or K3 Endo system (group 3). The results showed that these three rotary tapered systems were not significantly different with regard to breakage, while regarding distortion; there were no significant difference between the Protaper and K3 Endo and the ProFile and K3 Endo groups. Furthermore the results showed that there were significantly more distorted files in the ProFile group when compared with the Protaper group.

Parashos et al. 2004[6] examined a number of 7159 instruments of FlexMaster, GT, Orifice Shapers, ProFiles, Protaper, Quantec, Quantec Flare and HERO that were discarded by 14 endodontists in four countries

after clinical use. These instruments were collected between October 2000 and April 2003. It was found that unwinding occurred in 12% of instruments and fractures occurred in 5% (1.5% torsional fracture, 3.5% flexural fracture). It was found that the beginning point of unwinding of instruments occurred mostly at, or very close to, the tip of the instrument (1.0 ± 1.4 mm), with a range of 0 to 7.5 mm. The degree of unwinding of the 879 unwound instruments varied as follows: 45% unwound, 31% straight, 17% reversed and 6% twisted. It was also noted that the proportions of fractured instruments within various sizes were 15 (13%), 20 (4%), 25 (9%), 30 (2%), 35 (1%), and 40 (4%). The proportions of fractured instruments within various tapers were 0.02 (15%), 0.04 (2%), 0.06 (7%).

Di Fiore et al. 2006[7] determined the incidence of Profile nickel-titanium rotary instrument fracture. For their study 360 students used 2880 Profile Nickel-titanium rotary instruments to prepare 1440 simulated RC in 720 plastic teeth and another 2880 Profile to prepare 1440 natural RC in 720 extracted teeth. These Profile instruments were used in electric motors that were set at low torque level (less than 1 Ncm). It was found that the incidence of instrument fracture was 0.41% in plastic simulated canals and 0.31% in natural root canals. The overall incidence of instrument fracture was 0.36%.

Shen et al. 2009[8] analyzed a total of 1,071 ProFile 0.04, 432 ProFile series 29 0.04 and 1,895 Protaper rotary instruments. They wanted to see the incidence of deformation, fracture, instrument bend, unwinding, separation and the cause of separation in each of the three instruments. It was found that of the 1071 PF

instruments collected, no fractures were observed and only 8 (0.75%) revealed deformation without fracture. Three quarters of these instruments (six/eight) were size 25. Furthermore, no fractures or deformations were detected on the 432 PFS instruments. While of the 1895 PT instruments, 60 (3.17%) were deformed: 55 (2.9%) revealed deformation without fracture, and 5 (0.26%) were fractured. Of all defective instruments, the majority (57/60; 95%) had a macroscopic plastic distortion, whereas 36.67% (22/60) were bent, 48.33% (29/60) showed unwinding, and 10% (6/60) of the instruments revealed both twisting and unwinding on the same instrument. One third of the defective instruments (21/60) were Sx. Of all the unwound PT instruments (n = 29), Sx unwound the most often (n = 18) followed by S1 (n = 9). Of the five fractured PT files, three revealed shear (torsional) failure under fractographic examination.

Shen et al. 2009[9] analyzed the incidence of instrument separation of 3,706 Profile instruments during a predefined schedule of clinical use by the undergraduate students in a dental school over 4 years. They examined the lateral and fracture surfaces of 12 separated instruments and the location of the fractures