TEMPERATURE CHANGE ON THE EXTERNAL ROOT SURFACE DURING ULTRASONIC REMOVAL OF BROKEN INSTRUMENT

(An Invitro Study)

Thesis

Submitted to Endodontic Department,
Faculty of dentistry, Ain Shams University
In Partial Fulfillment of Requirements of
Master Degree in Endodontics

By

Moataz Magdy Mahran

(B.D.S)Faculty of Dentistry, Ain Shams University.
(2003)

Faculty of Dentistry
Ain Shams University
(2011)

INTRODUCTION

Success of endodontic treatment depends on different phases. One of the most important phases is cleaning and shaping. Cleaning and shaping can be performed by different intracanal rotary and hand instruments. Unfortunately, Limited flexibility and strength of intracanal instruments combined with improper use may result in intracanal instruments separation. This mishap can jeopardize the whole treatment plan. There are basically different approaches to remove and retrieve these separated instruments. Ultrasonic tips are one of the most successful approaches used nowadays to retrieve the separated instruments.

Ultrasonic tips with the help of some systems and devices based on "A tube slieve fit principle "as IRS (instrument removal system) increased the chances for instruments retrieval by exposing the coronal end of the instruments.

Attempted removal of the separated instruments using ultrasonic tips without good visualization increases the risk for ledges and perforations. Conversely, using an operating microscope greatly increases the chance for retrieval. Success of retrieval depends on canal anatomy, length of broken instruments, amount of remaining dentine, time and power used by different types of ultrasonic tips. The amount of heat

generated on the external root surface during ultrasonic tips vibration plays a role on the surrounding periodontium.

Many studies were carried out to detect the amount of heat generated on the external root surface during post removal. Few studies were performed to detect the amount of heat generated during broken instrument removal Thus; it was felt that studying the amount of heat generated on the external root surface using different types of ultrasonic tips during broken instruments removal will be of value.

REVIEW OF LITERATURE

In the practice of endodontics, clinicians may encounter a variety of unwanted procedural accidents and obstacles to normally routine therapy at almost any stage of treatment. One of these procedural problems is intracanal instruments fracture. Fractured root canal instruments may include endodontic files, Gates Glidden burs, lateral or finger spreaders, and paste fillers and they can be made from stainless steel, nickel-titanium (NiTi), or carbon steel. Fracture often results from incorrect use or overuse of endodontic instruments and seems to occur most commonly in the apical third of the root canal. The relatively recent advent of rotary NiTi root canal instruments has led to a perceived high risk of instruments fracture Furthermore, fracture of rotary NiTi instruments may occur without warning even with brand new instruments, whereas fracture of stainless steel files is preceded by instruments distortion serving as a warning of impending fracture. Various techniques have been introduced to remove broken instruments but the uses of ultrasonics have been one of the most famous techniques used nowadays**.** Many practitioners were concerned with the deleterious effects of ultrasonic usage. A review of the literature demonstrated that heat elevation and its potential effects on the periodontium are of significant interest. [(1)]

Incidence of instruments separation:

One of the complications of endodontic therapy is having an instrument fracture within the root canal space. Over the years as techniques and instrumentation have developed, there have been various types of endodontic instruments that have broken off in the canals. The incidence of separated instruments has risen, mainly because of the increased use of instruments especially in the untrained hand. Various factors have been associated with the fracture of instruments as operator experience, rotational speed, canal curvature, instrument design and technique, torque, manufacturing process, and absence of glide path. [(2)]

Mize et al. [(3)] investigated the effect of sterilization on cyclic fatigue of rotary Nickel-Titanium endodontic instruments. They used size 40 LightSpeed instruments and cycled them in artificial canals that were constructed from stainless-steel tubes with a 30-degree angle of curvature, and either 2 or 5 mm radius of curvature. Initially, they performed a pilot study to obtain the mean cycles to failure of presterilized and nonsterilized instruments at both the 2 and 5 mm radii. Then, they partially cycled instruments to a percentage of the mean cycles to failure and observed the effect of autoclave sterilization procedures (single and repeated) on the cyclic fatigue limit. They noticed that when the instruments were

cycled to only 25% the total cycles to failure, small cracks were visible (when viewed under SEM) in these instruments. However, they claimed that there were no statistically significant differences between presterilized and nonsterilized instruments regarding total cycles to failure. They found statistically significant differences in total cycles to failure only between instruments cycled in 2mm and 5mm radius canals. They concluded that heat treatment resulting from autoclave sterilization did not extend the useful life of Ni-Ti instruments, and reaffirmed the need to continually move the rotary instrument in and out of the canal, rather than letting it remain stationary in the canal.

Gabel et al. [4] studied the effect of rotational speed on Nickel-Titanium files distortion. They used 20 extracted human molars and instrumented them with Profile instruments placed in air motor with contra-angle 6:1 reduction, set at 166.67 rpm and 333.33 rpm.Then they evaluated them after instrumentation for distortion and/or separation. They found that only 8.7% of the files showed distortion or separation, most of them occurred in the apical 5 mm of the files. They claimed that files used at 333.33 rpm showed separation/distortion four times as often as files used at 166.67 rpm.

Dietz et al. [5] studied the effect of rotational speed on the breakage of Nickel-Titanium rotary files. In this study, they

used 72 Profile instruments (of sizes 3, 4 and 5) rotating at different rotational speeds (150, 250 and 350 rpm) in semicircular (5 mm. radius of curvature) bovine bone simulated root canals of identical size and radius for each file size group tested. They mounted the files in an electric motor with a 1:16 reduction contra-angle hand piece attached to an Instrument testing machine. The Instrument testing machine was adjusted to allow advancement of the files into the simulated canals at 5mm/min constant speed until separation occurred. They found that a rotational speed of 150 rpm delayed file breakage and allowed for a greater length of file tip penetration before breakage occurred when compared with a rotational speed of 350 rpm. They concluded that 0.04 taper nickel-titanium rotary file breakage was less likely to occur if the files are rotated at lower speeds.

Bortnick et al. [6] Compared Nickel-Titanium files distortion using electric and air-driven hand pieces. They used 20 extracted human molars and instrumented them with Profile instruments placed in electric motor hand piece with a contra-angle 16:1 reduction set at 150 rpm and another 20 extracted human molars and instrumented them with Profile instruments placed in air motor with contra-angle 6:1 reduction set at 166.67 rpm. Then they evaluated them after instrumentation for distortion and/or separation. They claimed no statistically

significant difference in files distortion incidence between the two hand pieces used in this study (5% distortion frequency in the air motor group and 4.38% in the electric motor group). They concluded that the type of hand piece used is not important as the speed at which the files were operated.

Castrisos et al. [7] surveyed methods used for post removal in specialist endodontic practice. A survey was sent to all 74 members of the Australian and New Zealand Academy of Endodontists, to gather information concerning root canal retreatment performed in specialist endodontic practice, attitudes about the risk of root fracture when removing posts and the methods used to remove different post system. They reported that when a post was present in a tooth that required root canal retreatment, 66% of the endodontists preferred to remove the post, while 27% considered either post removal or periapical surgery. They reported also that 34% reported that a root fracture had occurred during post removal, but this represented less than 0.002% of the estimated number of the posts removed by all respondents. Ultrasonic vibration was the most common method used to remove posts.

Timothy et al. [8] studied the deterioration of rotary nickel titanium files under controlled conditions. They used ISO size 20 files of 0.04 taper in the curved canals of extracted mandibular molars. The canals had been previously

instrumented to an ISO size 15 with stainless steel hand files. The irrigation used during rotary and hand instrumentation was GLYDE. The rotary files was examined by SEM before use to detect any defects, they were re examined after each of 5 uses to document deterioration. An electric hand piece was configured to rotate at 150 RPM and secured to the testing device which also held the extracted teeth, the testing device controlled load at 8 N, the depth of penetration for each canal and the rate of penetration (12mm/min.). Results showed surface fatigue wear and cracking of the used instruments, tortional moment was measured for used and the new instruments which wasn't affected by use.

Zelada et al. [9] investigated the effect of rotational speed and the curvature of root canals on the breakage of rotary endodontic instruments. They used 120 canals from extracted molars, and the angles and the radius of the curvatures of each root canal was ascertained. The teeth were then divided into 2 groups of 60, according to whether the angle of curvature was less than 30 degrees (group A) or greater than 30 degrees (group B). Then each group was then subdivided into 3 subgroups of 20 canals each, which underwent instrumentation at a different speed: 150, 250 and 350 rpm. Each file was used at one rotation speed only. They found that file breakage occurred in 12.5% of all the instrumented canals, all of which

took place in the group B canals (statistically significant compared to group A). They claimed that all breakage took place during the stage of the widening of the apical part of the canals and in the mesiao-buccal and disto-buccal. They claimed that there were no statistically significant differences in the frequency of breakages with respect to different rotational speeds in group B. They concluded that both the speed of rotation and the curvature of the root canals contribute to an increased risk of breakage of endodontic rotary instruments, yet the curvature would seem to be by far the most important factor.

Roland et al. [10] compared the rates of separation of 0.04 taper NI-TI rotary instruments using two different instrumentation techniques. 20 sets of 0.04 taper profile series 29 rotary instruments size 2 to 6 were used in the mesial mandibular or buccal maxillary canals of molars with 20 to 30 degrees curvature. The rotary instruments were used up to 20 times either with crown down technique or in a combination with pre flaring with hand files in passive step-back technique. Results showed that passive step-back technique allowed for more uses before separation than crown down technique recommended by the manufacturer.

Patino et al. [11] investigated the influence of a manual glide path on the separation rate of NiTi rotary instruments.

They used in their study 208 canals obtained from extracted human mandibular and maxillary molars and had an angle of curvature that was greater than 30^{o}. They found that a total of 25 files broke in 25 canals: 9 K3 files through 56 canals prepared, 7 Profile files through 55 canals prepared and 9 ProTaper files through 94 canals prepared (No significant difference). They claimed that the file breakage rate increased as the radius of curvature decreased and as the angle of curvature increased. They also claimed that only one file broke when first used, and the highest breakage rate was for files that were used 8 times or more. They suggested that the low breakage rate obtained in the present study is largely attributable to the use of hand files to prepare a sufficiently wide and smooth-walled glide path in the apical 1/3 of the canal, before introducing rotary files to the working length.

Suter et al. [12] investigated the probability of removing fractured instruments from root canals. They used in their study 18-month period all referred endodontic cases involving fractured instruments within root canals. The protocol for removal of fractured instruments was: create straight-line access to the coronal portion of the fractured instruments, attempt to create a ditched groove around the coronal aspect of the instruments using ultrasonic files and/or to bypass it with K-Files. Subsequently, the fractured instruments were vibrated

ultrasonically and flushed out of the root canal. The location of the fractured instruments and the time required for removal were recorded. They found that in total, 97 cases of instruments fracture, 84 instruments (87%) were removed successfully. There was a significant correlation between the time needed to remove the fractured instruments and a decrease in success rate. They claimed that there was no statistically significant difference in the success rate with respect to the location of the fractured instrument (tooth/root type), the type of fractured instruments or the different methods of instruments removal. They concluded that curved canals were a higher risk for instruments fracture than straight canals, and that a decrease in the success rate was evident with increasing treatment time.

Souter et al. [13] studied the complications encountered in vitro and in vivo as a result of fractured file removal using the recently proposed technique. In the experimental Study, they used sixty sound extracted mandibular molars in which they fractured standardized lengths of #35/.04 taper ProFile rotary files at different levels inside root canals. Following straight-line access modified Gates Glidden burs were used to create a staging platform, followed by the use of fine ultrasonic tips to trough around and then remove the broken instruments. Root strength was determined by advancing a narrow, tapered probe into the obturated canals at a rate of 3 mm/min until fracture of

the root occurred. They reported that removal was successful in all cases where the files fragments were located in the coronal or middle third. Only 1 of the 15 files located in the apical third were successfully removed. Stripping perforations occurred in three cases, all where the fragments were located beyond the curve. They also reported that removal procedure significantly reduced root strength when the files were located in the middle or apical third of the root by 30% and 40% respectively. In the Clinical Study, Souter et al. reviewed clinical cases involving attempted fragment removal over a 3 yr period, with respect to success of file removal and evidence of damage (i.e. perforations). They reported that removal was successful in all cases with the file fragment lodged in the coronal third (11 cases) or the middle third (22 cases), with no perforations occurring. Only nine of the 27 cases involving the apical third were successful, with seven perforations resulting.

Knowles et al. [14] evaluated the incidence of instruments separation using light speed rotary instruments. A total of 3543 canal were treated over a 24 months period and during that time 46 light speed instruments were separated and found to be non retrievable, resulting in separation rate of 1.30%.

Parashos et al. [15] reported some factors predisposing to fracture of rotary NiTi instruments such as the instrument design, manufacturing process, dynamics of instrument use,

root canal configuration, Preparation/Instrumentation Technique, and number of uses. They also suggested some guidelines to minimize the risk of fracture in clinical practice such as to ensure straight line access, to use a crown-down shaping technique, to use a light touch only, to replace files sooner after use in very narrow and very curved canals, to examine files regularly during use, preferably with magnification, and to keep the instrument moving in a chamber flooded with sodium hypochlorite. Parashos et al. reported that through there review of literature, many papers have been contradictory, and unsubstantiated, and were based on small and often unstated numbers of cases regarding the influence of retained broken instruments on the prognosis of root canal treatment. Parashos et al. reported that incorporation of the operating microscope and ultrasonic's in removal of fractured instruments considerably improved the chances of removal, but they stressed that attempts to bypass a fractured instrument should always be initially considered.

Iqbal et al. [16] investigated the incidence of hand and rotary instruments separation in the endodontic graduate program at the University of Pennsylvania between 2000 and 2004. In 4865 endodontic resident cases the incident of hand and rotary IS was 0.25% and 1.68% respectively. The odds for IS were seven times more than for hand IS. The probability of

separating files in the apical third was 33 and 6 times more likely when compared to the coronal and middle third of the canal. The highest percentage of IS occurred in mandibular and maxillary molars, furthermore the odds of separating files in molar were 2.9 times than premolars. There was no significant difference in IS between the use of torque control versus non torque control hand pieces.

Methods of instruments retrieval:

Separation of endodontic files is a common incident during root canal treatment that prevents efficient cleaning and shaping of the root canal and may result in treatment failure. Although removal of fractured instruments may be difficult, an attempt is recommended when no complications are predicted [(17)]. Many techniques have been used for the retrieval of separated endodontic files. Ultrasonics has been reported as being the most frequently used technique [(17)]. Ultrasonic tips with the help of some systems and devices based on "A tube slieve fit principle "as IRS (instrument removal system) increased the chances for instruments retrieval by exposing the coronal end of the instruments.[(17)]

Krell et al. [(18)] described some conservative methods for the retrieval of silver cones from root canals utilizing ultrasonic scalar. One of these techniques was used to remove silver