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Cleaning Efficiency of Nickel Titanium GT and .04 Rotary Files when used in a Torque Controlled Rotary Handpiece

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A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Dentistry at Virginia Commonwealth University

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ABSTRACT

CLEANING EFFICIENCY OF NICKEL TITANIUM GT AND .04 ROTARY FILES WHEN USED IN A TORQUE CONTROLLED ROTARY HANDPIECE

By Calvin B. Suffridge, DDS

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science at Virginia Commonwealth University.

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This study determined if the cleaning efficiency of NiTi rotary files in an endodontic electric handpiece using a no torque control setting was superior to that obtained when using the torque control feature. Fifty extracted human anterior teeth with straight canals were divided into two groups of 20 and two control groups of 5. Canals were instrumented with GT and .04 Profile NiTi files until a size 35 advanced to working length. Samples were sectioned,

the apical 6 mm of the canal was photographed (x20) and projected onto a 3 x 4 foot grid with squares measuring 0.5 inches each. Total debris was the percentage of the number of squares containing debris versus the total number of squares. Results showed that the teeth in the torque controlled group showed an average of 24.99% debris vs. 15.55% for the teeth in the no torque group. The difference was not statistically significant.

Introduction

Proper biomechanical cleaning and shaping of canals is the foundation for successful endodontic therapy (1). Instrumentation can be carried out with hand files, ultrasonics, rotary driven files or a combination of these methods. Beeson et al (2) showed that the use of rotary nickel titanium files for canal preparation helped to significantly reduce the time required to instrument canals when compared to hand instrumentation with K-files. They also showed that rotary instrumentation, when carried out one mm short of the radiographic apex, significantly reduced the amount of debris extruded apically.

The introduction of Nickel Titanium rotary instrumentation in Endodontics has produced several unit variations and models of handpieces to operate these files. A common problem encountered with NiTi rotary instruments is the increased risk of file breakage when a file binds in the canal. Fracture of nickel titanium rotary files is a procedural error which may influence the success or failure

of a particular case of root canal therapy (3). If a high torque motor is used, the instrument's specific limit-torque (fracture limit) is often exceeded, thus increasing the risk of instrument failure. A possible solution to this problem would be to use a low-torque endodontic motor which could operate below the limit of elasticity of the file. If the torque is set just below this limit, the risk of fracture should be markedly reduced.(4)

According to one manufacturer (Nouvag AG), this problem has been reduced with the introduction of their torque controlled rotary handpiece unit: Nouvag Torque Control Motor (TCM) rotary unit (Nouvag AG, Goldach, Switzerland). The "torque control" provides four different torque settings (1 Ncm, 1.5 Ncm, 2.0 Ncm, and 3.0 Ncm) which correspond to the maximum reachable torque(5). One Ncm equals 0.2245 lbs. The unit has the ability to reverse the file rotation in the canal when resistance is met at these torque settings. Even though this offers a perceived reduced incidence of file breakage, the efficiency of the files ability to cleanse the canal wall with such a system is unknown. A literature search revealed no studies which

examined the canal cleaning efficiency of NiTi rotary files when used in a rotary unit with a torque control feature.

The purpose of this study was to determine the cleaning efficiency of NiTi files when used with the Nouvag Torque Control Motor. Specifically, the aim of this study was to determine if the cleaning efficiency using a no torque control setting was superior to that obtained when using the torque control feature.

Materials & Methods

The study observed canal cleanliness in the apical one third of the root canal after instrumentation with GT and ISO .04 Profile NiTi rotary files (Dentsply Tulsa Dental, Tulsa, OK) using the manufacturer's recommended sequence of files and a crown-down preparation technique.(6) Two torque modes were compared. With the torque control feature engaged, the unit was set at the manufacturer's recommended speed, 300 rpm (6), and at the lowest torque setting 1 (1 Ncm). This torque mode was compared to a no torque mode at the same speed (300 rpm).

Fifty extracted human anterior teeth with straight canals were randomly divided into two experimental groups of 20 each and two control groups of 5 each (positive and negative control group). The crown was sectioned off each tooth at the CEJ prior to instrumentation in order to standardize canal length. Working length (WL) was determined by placing a size 10 file in the canal until the tip was just visible at the apical foramen using x3.25

magnification. One mm was then subtracted from this length to determine the final WL (7). All canals were instrumented with handfiles (Flex-O files, Dentsply Maillefer, Tulsa, OK) until a size 20 bound at the WL. Specimens whose root canals initially were larger than a size 20 file at the established working length were excluded. Rotary instrumentation was carried out in a crown down manner using the manufacturer's recommendation with regard to file sequence. The recommended sequence for file use is as follows: (size of file at tip/ taper of file): 20/.10, 20/.08, 20/.06, 35/.04, 30/.04, 25/.04, 20/.04. (6) Each file was used in the canal for seven seconds, which is the manufacturer's recommended maximum working time. Canal preparation was continued until a Profile size 35/.04 could be advanced to working length. After each use the files were cleaned of debris with a sponge and checked for signs of wear or distortion. Each set of files was used in the preparation of one tooth and then discarded as per manufacturer's recommendation. (6)

Group A (20 teeth) were instrumented using the Nouvag Torque control motor set at the manufacture's recommended speed (300 RPM) and a torque setting of 1.0 Ncm. Group B

(20 teeth) were instrumented using the unit set at the same speed (300 RPM) and at the infinity setting (no torque control). Group C (5 teeth) served as the negative control group and were not accessed or instrumented. Group D (5 teeth) served as the positive control group. This group was accessed, hand instrumented to size 20 FlexOFile, and irrigated only. No rotary instrumentation was carried out in this group.

One operator completed all instrumentation. Canals were irrigated with 1 ml of 5.25% NaOCl after each file use and a final flush of 10 ml after all instrumentation was completed. Once all teeth were instrumented, irrigated, and dried with paper points they were sealed with a cotton pellet and Cavit (3M ESPE, St. Paul, MN), to prevent contamination of the root canal space. The teeth were then sectioned by notching the root on the buccal and lingual surfaces and then separating the two halves with a chisel and mallet. Canal cleanliness was determined using a method similar to that described by Jensen and Walker (8) and Wu and Wesselink (9). The apical 6 mm of the root canal wall was photographed at x20 magnification using a dissecting microscope. Photomicrographs of each specimen were

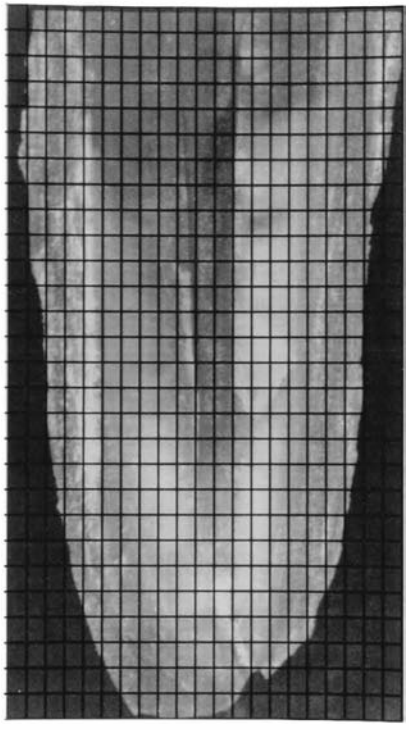

Figure 1. Grid for Scoring Debris

projected onto a 3 x 4 foot grid with squares measuring 0.5 inches each (Fig. 1). The total number of squares present in each area of the canal was determined. The cleanliness of the canal was then determined by counting the total number of squares containing debris. The total amount of debris was expressed as a percentage of the number of squares containing debris versus the total number of squares present in that sample. The data was then analyzed using a Student's t-test ($p = 0.05$). The percentage of spaces with debris was the variable of interest.

Results

The proportion of canal spaces with debris was compared for the two experimental groups. The mean debris scores for each group and the range within one standard deviation are shown in Table 1 and Figure 2. The negative control group of uninstrumented samples showed 97.70% debris covered spaces (Fig. 3), while the positive control group, which were hand filed to size 20, had a debris score of 45.65%. The teeth in the torque controlled group (Fig. 4) showed spaces with an average of 24.99% debris as compared to 15.55% for the teeth in the no torque group (Fig. 5). Using the Student t-test, the difference in these proportions was not significant. ($t = 1.78$, $df = 38$, p-value = 0.0826). The analysis was repeated using an unequal-variance t-test and similar results were obtained.

Table 1. Debris Score Percentage of each group ± SD

Group	N	Mean ± SD
Controls		
Negative	5	97.70 ± 5.15
Positive	5	45.65 ± 36.58
Experimental Groups		
No torque control	20	15.55 ± 8.28*
Torque control	20	24.99 ± 22.19*

*Debris scores among groups not significant, Student t-test, t = 1.78, df = 38, p = 0.0826

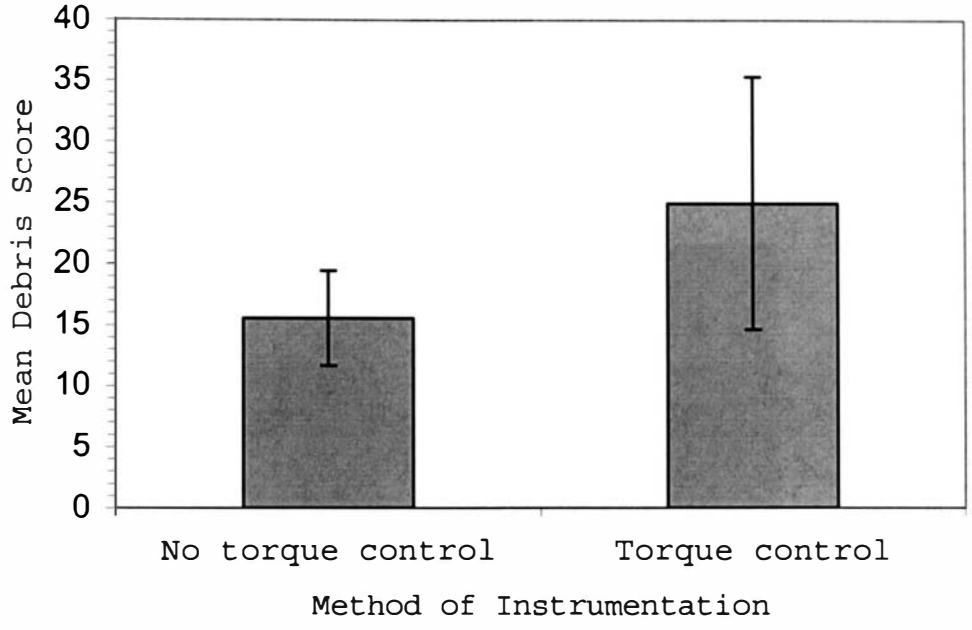

Figure 2. Mean Percentage Debris Score

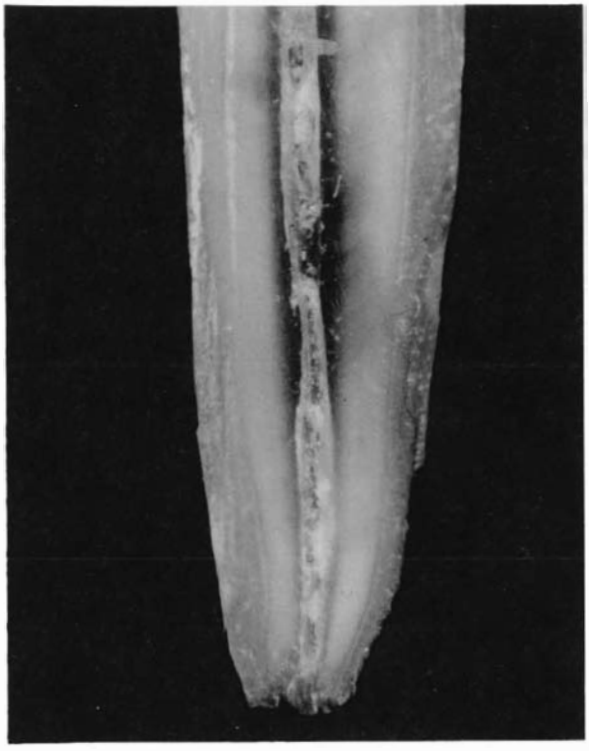

Figure 3. Negative Control Specimen

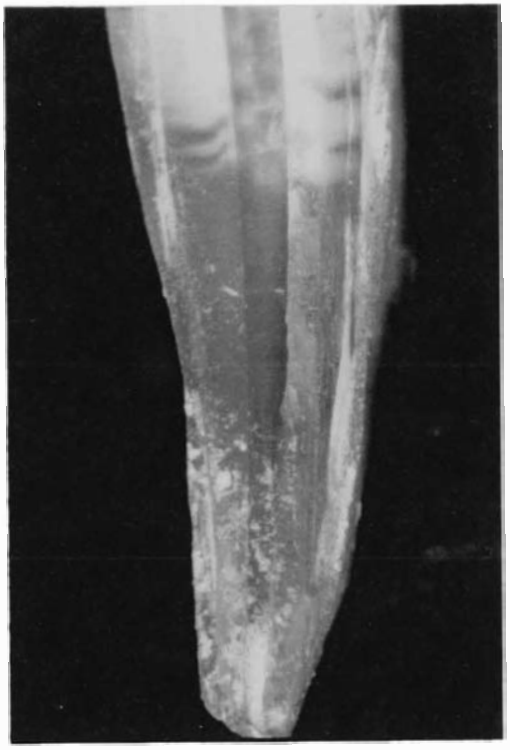

Figure 4. Torque Control Specimen

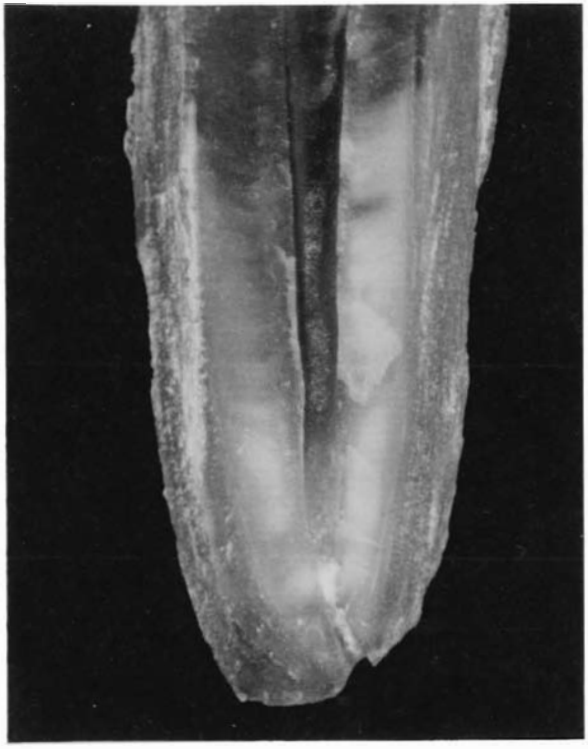

Figure 5. No Torque Control Specimen

Discussion

Rotary Nickel Titanium files are widely used today as a method of preparing the root canal system. The torque controlled handpiece is designed to stop and reverse the rotation of a file when its torque value is reached thus preventing file breakage. The question then becomes, what impact does this automatic reversal have on the ability of the files to cleanse that portion of the root canal system? Prior to this study, the literature contained no comparative information and it remained unknown if rotary files used in a torque control handpiece would clean the canal equal to that of rotary files used without torque control.

The results of this study indicate that there is no statistically significant difference in canal cleanliness when comparing these two rotary methods of canal instrumentation. Even though no statistically significant difference was found, the canals in the group with no torque control had a tendency to be cleaner, with only sixteen percent debris filled spaces, compared to the

torque controlled group with twenty-five percent debris filled spaces.

Our study used a debris scoring method similar to that described by Jensen and Walker (8) and Wu and Wesselink (9). Methods used in the past required a subjective assessment by an examiner to collect the nominal or ordinal data using an index or criteria ranging from no debris to heavy debris amounts. The grid method of scoring seems to provide a less subjective and more accurate method to quantify remaining debris.

A difficult variable to control in any study using human teeth is the wide variation in canal morphology (8). Although an attempt was made to standardize the starting size of the apical portion of the canal, the remaining canal diameter was found to be quite variable. The role this variation would have on the ability of the torque-controlled file to instrument the canal walls remains to be determined. Further study is also required as to how the torque controlled files would perform in cleaning small curved canals. Plastic blocks would offer some standardization of canal size but the cutting

characteristics of the files on plastic is different from that of natural tooth structure (10).

The handling characteristics of the handpiece in either the torque or non-torque settings were found to be similar. The operator must still recognize when the file is binding and the torque limit of the unit has been met so that the file can be removed from the canal. The Nouvag TCM unit offers a visible readout scale which alerts the operator that there is increased torque on the file; however, unlike other torque control units it does not offer an audible warning signal. The operator, through the handpiece, can feel the file when it stops and begins to rotate backwards the standard two revolutions and then reverts to the original direction of rotation. It is important to be aware of this occurance in order to remove the file from the tooth and clean the debris from the flutes. This variable could affect the final results with regard to canal cleanliness.

It was interesting to note that among the files used in this study, only one Profile, size 35/.04, was found to be distorted. This file was used in the no-torque controlled group and was therefore not protected against

exceeding the torque limits. According to Yared, et al. (10), torque is a parameter that might influence the incidence of an instrument becoming locked in the canal, deformed, and separated. Theoretically, an instrument used with no torque control would be very aggressive in its cutting action and the incidence of instrument locking, deformation and separation would tend to increase. With torque control, cutting efficiency of the instrument may be reduced and progression of the file into the apical portion of the canal may be more difficult. In this latter situation the operator must avoid forcing the instrument into the canal as this might contribute to instrument locking, deformation, and separation (11). In this study, no difference was found between the two groups and this may have been due to the larger sizes of the canals and operator familiarity with the technique. Studies have reported that proper training will minimize the incidence of complications when using rotary NiTi instruments. (12)

In conclusion, although neither technique produced a completely clean root canal, this study indicated a tendency for the torque controlled rotary handpiece group to have a greater number of areas with debris present as

compared to the samples in the group cleaned without torque control. This difference however was not found to be statistically significant.

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Vita