INSTRUMENTATION TIME AND ABERRATION INCIDENCE WITH ENDOSEQUENCE ROTARY NiTi SYSTEM IN COMPARISON TO THREE OTHER COMMONLY USED ROTARY NiTi SYSTEMS

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ABSTRACT

The aim of this study was to assess the shaping ability of EndoSequence rotary NiTi system and compare it with three commonly used rotary NiTi systems. A total of sixty resin simulated root canal blocks were instrumented with EndoSequence, ProTaper, RaCe and Profile to size #30 as Master Apical File (MAF). Pre- and post-instrumentation images were superimposed using a computer image analysis program and evaluated for presence of zipping, ledging or perforation. Further analysis was done by calculating the amount of transportation at the middle and the apical thirds. One-way analysis of variance (ANOVA) and Duncan's multiple range tests were used for statistical analysis. EndoSequence and RaCe groups took significantly less instrumentation time compared with Profile and ProTaper groups (P-value < 0.05). No significant difference was found among the groups in terms of zipping, ledging and perforation (P-value > 0.05). The EndoSequence rotary NiTi system was found to be more efficient and safe with minimal canal aberrations in comparison with the other systems.

Key words: *EndoSequence system, root canal preparation, simulated canals*

INTRODUCTION

One of the main objectives of root canal preparation is to shape and clean the root canal system effectively while maintaining the original configuration, without creating any iatrogenic events such as instrument fracture, external transportation, ledge or perforation.[1] Because of the aberrations created following the use of stainless steel hand files in curved canals, various types of Nickel titanium (NiTi) files were introduced.[2] NiTi endodontic instruments were found to have more elastic flexibility and superior resistance to torsional fracture compared to similar sized stainless steel files.[3] In contrast to stainless steel hand files, nickel titanium endodontic files are formed by grinding a blank and not twisting. Thus, NiTi instruments are able to maintain the original canal shape without creating severe canal aberrations such as zips and ledges particularly in narrow and severely curved canals, and in addition they reduce the number of procedural steps.[4]

The EndoSequence files (Real WorldEndo, Brasseler USA, Savannah, GA) address the concerns of previous file design by creating an efficient, safe file with a short learning curve that allows the practitioner to create well-instrumented (milled) canals.[5] EndoSequence NiTi rotary system has been introduced to the market by Brasseler Company (Brasseler USA, Savannah, GA). It was claimed to possess maximized flexibility and efficiency.[6] The file design employed by the EndoSequence instruments provides for alternating contact points (ACP) along the instrument's cutting length. The use of ACP allows the file to remain centered in the canal, while simultaneously reducing the torque requirements. The lack of radial lands provides a sharper and flexible instrument as a result of a decreased thickness of metal.[7] Combined with a precision tip, the alternating contact points provide an efficient instrument that will not transport the canal.

When analyzing the quality of root canal preparation, several parameters are of interest: cleaning ability, shaping ability and safety issues. Several investigations on the shaping ability of root canal instruments have been performed by using simulated root canals in resin blocks, because they allow standardization of degree, length and radius of curvature, reproducible hardness and abrasion characteristics and standardized diameter and taper.[4] The aim of the present study was to compare the shaping ability of EndoSequence rotary system with three commonly used NiTi systems (ProTaper, Race and Profile) in terms of instrumentation time and incidence of canal aberration in resin simulated root canal blocks.

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METHODOLOGY

Samples and Instruments

Sixty resin simulated root canal blocks (Endo Training-bloc, .02 taper, curvature of 40°, Dentsply) were used for the study. All blocks were covered with adhesive tape before preparation. Four rotary systems were studied with 15 blocks in each group. The file systems used were ProFile (Dentsply Maillefer, Ballaigues, Switzerland), ProTaper (Dentsply Maillefer, Ballaigues, Switzerland), RaCe (FKG Dentaire, La-chaux-de-fonds, Switzerland), and EndoSequence (Brasseler, USA).

Preparation of Simulated Canals

Sixty simulated canals were prepared by the same operator, a skilled general practitioner. Working length was determined visually inserting #10 stainless steel K-file until the tip was visible at the apical foramen then 1mm was subtracted. Each 15 canals in each group were prepared at a time. Preparation was done at a speed of 250 rpm (600 rpm with the EndoSequence group) and a torque-control level of 1 using an 8:1 reduction hand-piece powered by an electric motor (TCM Endo, Nouvag, Goldach, Switzerland). With passive, gentle pressure crown-down technique was used according to the manufacturer instructions of each file system. Recapitulation with smaller files was done. All canals were instrumented to size #30 as apical final preparation. Copious irrigation with water was performed between every file using a 27 gauge irrigation needle (Microlance™3 BD Drogheda, Ireland). The file was coated with endogel (Jordco Dental Products, USA) before introducing it in the canal. Files were wiped regularly with a piece of 2" x 2" gauze and examined carefully for sign of instrument failure after use such as bending, deformation or unwinding. Failed and deformed file size was recorded before discarding. Each file was used for a maximum of two canals. The time of instrumentation (total active instrumentation, irrigation and the time taken to exchange the instrument) was recorded in minutes.

Instrumentation Sequence

ProTaper Group (PT)

ProTaper shaper files SX (19/.035-.19), S1 (17/.02-.11) and S2 (20/.04-.115) were used for coronal and middle third flaring. Apical finishing was done with finishing files F1 (20/.07-.055), F2 (25/.08-.055) and F3 (30/.09-.05).

RaCe Group (RC)

PRE-RaCe files (40/.10) and (35/.08) were used for coronal flaring. Apical shaping was done using (25/.06) and (30/.06) RaCe files.

EndoSequence Group (ES)

An expeditor file (27/.04) was inserted until resistance was encountered. EndoSequence files (40/.06), (35/.06) and (30/.06) were used.

Profile Group (PF)

Coronal flaring was done with Profile orifice shapers (35/.12) and (50/.07). Then, Profile (40/.06), (35/.06) and (30/.06) files were used.

Image Analysis and Assessment

Pre- and post-operative images with high resolution (2500 x 1673 pixels) were captured and superimposed by a professional photographer using FinePix S3Pro digital camera (Fujifilm, Japan) and Adobe Photoshop® software (Adobe, USA). Superimposed images were presented in random order to an endodontist for evaluation of the presence of zipping, ledging or perforation. The endodontist was not aware of the system used in each canal.

Further analysis was done to the superimposed images by selecting two points. The first point was at the beginning of the curvature in the middle third. The second point was in the apical third at the end of the curvature (Figure 1). Amount of cutting in the inner and outer walls was measured using Image J (National Institute of Health, USA). Measurement was done on the magnified images in mili-meters at right angle to the canal surface. Degree of transportation was determined by calculating the difference between amount of cutting in the inner and outer wall at each point

Statistical Analysis

The data were entered in MS Excel and analyzed using Statistical Package for Social Sciences (SPSS windows standard version 11.0, SPSS Inc, USA). Descriptive statistics (means, standard deviations and proportions) were used to summarize the quantitative and qualitative variables. One-way analysis of variance (ANOVA) was used to compare the mean values of quantitative outcome variables (time, zipping, ledging, perforation, danger zone preparation and transportation) across the four groups (ProTaper, RaCe, EndoSequence and Profile). Further, Duncan's multiple range tests was used for pair wise comparison of groups. Chi-square test was used to observe the significant difference among the four groups in relation to

Fig 1: Image analysis for calculating amount of transportation

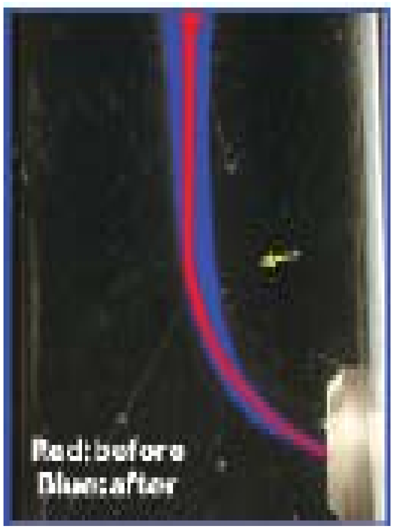

Fig 2: Superimposed image of simulated canal showing danger zone preparation (ProTaper group)

Fig 3: Superimposed image of simulated canal showing continuous tapering with minimal transportation (EndoSequence group)

qualitative outcome variables (zipping, ledging, elbow preparation, perforation). A P-value of < 0.05 was considered as statistically significant.

RESULTS

Five instruments in ProTaper group were deformed, two F1 and three F2. The instrumentation time results are summarized in Table 1. After elimination of perforated canals, canals prepared with EndoSequence and RaCe required significantly less time compared with Profile and ProTaper groups (P-value < 0.05). Zipping, ledging, and perforation results are summarized in Table 2, and differences of cutting in the inner and outer walls are shown in Table 3. RaCe show no aberrations while ProTaper and Profile had 3 aberrations from the total test samples. No statistical significant difference was found among the groups (P > 0.05). ProTaper, RaCe and EndoSequence groups showed tendency to cut more resin in the inner wall at

TABLE 1: COMPARISON OF MEAN INSTRUMENTATION TIME (MINUTES) BETWEEN VARIOUS NiTi ROTARY SYSTEMS

Type of NiTi System	Instrumentation TimeMean ±SD
EndoSeq (n=15)	2.87 ±0.89
RaCe (n=15)	3.32 ±0.61
Profile (n=12)	8.15 ±2.39
ProTaper (n=15)	10.35 ±2.56

TABLE 2: INCIDENCE OF CANAL ABERRATION

Aberration	EndoSeq (n=15)	RaCe (n=15)	Profile (n=15)	ProTaper (n=15)
Zipping	1	0	0	**0**
Ledging	1	0	0	**3**
Perforation	0	0	3	**0**

TABLE 3: AMOUNT OF CANAL TRANSPORTATION (IN MM) MEASURED FROM THE MAGNIFIED IMAGES

Type of Ni Ti System	Difference of cutting at the middle 1/3 (danger zone) Mean ± SD	Difference of cutting at the apical 1/3 (elbow prep) Mean ± SD
ProTaper	3.22 ± 0.71†	1.92 ± 1.14
Endosequence	1.47 ± 1.64	1.53 ± 1.08
RaCe	1.61 ± 0.74	1.83 ± 1.41
Profile	-0.61 ± 1.18*	0.64 ± 0.47

P-value > 0.05, *cutting in the outer wall, † p –value < 0.001

the middle third. Profile group showed tendency to cut more resin in the outer wall at the middle third. However, ProTaper significantly cut more resin (P-value < 0.0001). All groups showed tendency to cut in the outer wall at the apical third with no significant difference in amount of resin removed (P-value > 0.05).

DISCUSSION

The objective during instrumentation of a root canal is to maintain the original canal curvature in order to produce continuously tapering and conical forms with the smallest diameter at the end point of the preparation.[8] Root canal shaping procedure is difficult when relatively non tapered instrument are used to create tapered root canal shapes[2]. With the introduction of more tapered NiTi rotary instruments this difficulty was alleviated and it became possible to produce a better centered and rounder canal preparation when compared with hand operated files.[9]

Simulated canals in clear resin blocks have been shown to represent a valid experimental model.[10] They allow assessment of the outcome of canal shaping and instrument performance under standardized condition. However, it is accepted that the experimental model has limitations and caution should be exercised when extrapolating the results to real teeth.[11]

Previously, it had been thought that radial lands were a requirement to maintain a rotary file centered in a canal. However, newer NiTi systems have non-landed files with smaller cross sectional area that maximize the flexibility and decrease the required torque.[12]

The present results have indicated that EndoSequence and RaCe groups require significantly less instrumentation time. This can be attributed to their cutting efficiency due to incorporating positive rake angle in their cross sectional design whilst Profile instruments have a neutral rake angle.[8] Schafer et al.[12] found a significant correlation between the bending properties and the cross sectional surface area of different NiTi rotary instruments.

No significant difference was found in zipping, ledging and perforation among the four tested groups. In the Profile group, three canals were perforated which could be due to the instrument stiffness and lack of flexibility in non landed files.[7] In EndoSequence, RaCe and ProTaper groups, all canals showed tendency to transport the canal to the inner curve (danger zone) as shown in Figure 2. This aberration may be caused by ProTaper finishing files, which appear to be less flexible than other files of the same tip size.[13] However, the mean of resin removal in the inner wall at the middle third was significantly higher in ProTaper group (P-value < 0.001). This finding was in concordance with results of a previous study.[14] In this study, EndoSequence files provided a centered canal preparation with minimal canal aberration (Figure 3). The aberration observed in the EndoSequence group is probably the result of excessive force applied in combination with less than ideal model material.

CONCLUSION

Within the limitations of this *in vitro* study, EndoSequence rotary NiTi files prepared simulated canals rapidly and safely with minimal canal aberration. Further clinical investigations are required to fully assess EndoSequence shaping ability.

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