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ORIGINAL RESEARCH

Comparison of Air-driven *vs* Electric Torque Control Motors on Canal Centering Ability by ProTaper NiTi Rotary Instruments

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ABSTRACT

Aim: Cleaning and shaping is one of the most important phases in root canal therapy. Various rotary NiTi systems minimize accidents and facilitate the shaping process. Todays NiTi files are used with air-driven and electric handpieces. This study compared the canal centering after instrumentation using the ProTaper system using Endo IT, electric torque-control motor, and NSK air-driven handpiece.

Materials and methods: This *ex vivo* randomized controlled trial study involved 26 mesial mandibular root canals with 10 to 35° curvature. The roots were randomly divided into 2 groups of 13 canals each. The roots were mounted in an endodontic cube with acrylic resin, sectioned horizontally at 2, 6 and 10 mm from the apex and then reassembled. The canals were instrumented according to the manufacturer's instructions using ProTaper rotary files and electric torque-control motors (group 1) or air-driven handpieces (group 2). Photographs of the cross-sections included shots before and after instrumentation, and image analysis was performed using Photoshop software. The centering ability and canal transportation was also evaluated. Repeated measurement and independent t-test provided statistical analysis of canal transportation.

Results: The comparison of the rate of transportation toward internal or external walls between the two groups was not statistically significant ($p = 0.62$). Comparison of the rate of transportation of sections within one group was not significant ($p = 0.28$).

Conclusion: Use of rotary NiTi file with either electric torque-control motor or air-driven handpiece had no effect on canal centering.

Clinical significance: NiTi rotary instruments can be used with air-driven motors without any considerable changes in root canal anatomy, however it needs the clinician to be expert.

Keywords: Canal centering, ProTaper, Electric torque-control motor, Air-driven handpiece.

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INTRODUCTION

An ideal preparation shape of a root canal system is one of the major goals in root canal treatment. It should have a continuously tapered funnel form, with the diameter decreasing from the orifice to the apex, to facilitate proper irrigation and obturation.[1-4] The original shape of the canal is also important; otherwise, canal transportation, perforation, and ledge formation will occur in severely curved canals, especially with traditional stainless steel instruments.[5] Because of stiffness and inflexibility, these instruments tend to cut the outer wall dentin of curved canals.[6] Cleaning and shaping with manual instruments makes the procedures quite time consuming and tedious.[7]

In response to these issues, nickel-titanium (NiTi) rotary instruments have been introduced in dentistry.[8] They are superior to traditional stainless steel instruments as far as cutting efficacy is concerned, torsional resistance and flexibility.[9] NiTi rotary instruments can maintain the original canal shape while minimizing procedural mishaps, especially in narrow and severely curved canals.[10] Canal preparation with rotary NiTi systems is centered in the canal space for a significantly shorter period in comparison with manual stainless steel instruments.[9-11] However, despite these advantages, instrument fracture while using NiTi rotary files can occur.[12] Therefore, in order to minimize the risk of intracanal instrument separation, the use of special motors or handpieces is recommended. Several automated devices, including electric high- and low-torque control motors and air-driven torque-limited rotation handpieces, have been developed for this purpose.[13]

Gambarini showed that endodontic motors with lower torque values causes lower cyclic fatigue in NiTi rotary instruments.[14]

Berutti et al[15] compared low and high torque for Pro Taper instruments and showed all ProTaper instruments worked better at high torque.

Bardsley et al[16] showed that rotational 400 RPM speed generated less torque and force in comparison with 200 RPM.

Routinely, in dental offices, NiTi rotary instruments are used with air-driven handpieces that lack torque, speed, and force setting necessary for safety and optimal utilization of these files. Thus, the aim of the present study was to compare canal transportation following preparation with ProTaper NiTi rotary instruments using electric torque control motors and air-driven handpieces.

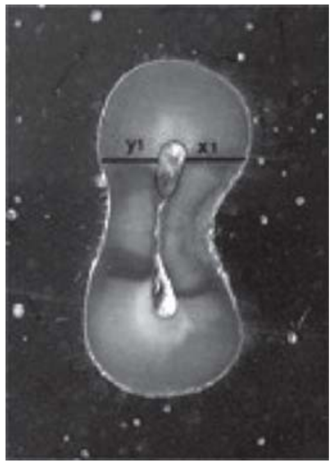

Fig. 1: Canal configuration before preparation

Fig. 2: Canal configuration after preparation

MATERIALS AND METHODS

Thirteen mesial roots (type 3 Weine) from extracted mandibular first molars (thirteen mesiobuccal and thirteen mesiolingual canals) with curvatures ranging from 10 to 35° according to the Schneider method, which each canal negotiated by a scouter file and confirmed by X-ray, were selected.[17] After the teeth were decoronated to a root length of 10 mm, The working length was determined by inserting a #10K-file (Dentsply Maillefer, Ballaigues, Switzerland) into the canal until it was just visible at the apical foramen, then subtracting 1 mm. Then apical preparation was initiated with a #15 K-file (Dentsply Maillefer, Ballaigues, Switzerland) using Glyde (Dentsply Maillefer, Ballaigues, Switzerland) as a lubricant to establish a glide path for rotary preparation.

The root specimens were embedded in resin using a modified Bramante muffle system as reported by Short et al.[18] The muffle consisted of custom-machined and indexed molds that could be disassembled and reassembled for measurement and canal preparation (Figs 1 and 2). Clear casting resin (Chemco Resin Crafts, Dublin, CA) was poured into the muffle to approximate the level of cementoenamel junction. A hollow brass tube (0.033 inches inside diameter) was embedded in the resin to maintain precise alignment of the sections. After polymerization of the resin and disassembly, the specimens were sectioned horizontally at 2 and 6 mm, and the third section was at orifice level from the apex with an Isomet slow-speed saw (Buehler Co., Evanston, IL). The sections were photographed using a digital camera (Canon Ixus 850 Is, 10 mega pixels, zoom lens 5*15, distance to the object = 10 cm, Canon Co., Tokyo, Japan). The sections were reassembled in muffle system for canal preparation. The specimens were randomly divided into 2 experimental groups of 13 canals, Ml or MB canal in each root. Canal preparation was performed using ProTaper rotary NiTi instruments (Dentsply Maillefer, Ballaigues, Switzerland) in the traditional ‘Crown-Down technique’ using Endo IT motors (VDW, Munich, Germany), with 350 RPM and torque were adjusted according to the manufacturer’s instructions. in group 1; and an air-driven torque-limited rotation handpiece (1/64 speed reduction) (NSK, Tokyo, Japan) in group 2.

According to the manufacturer’s guidelines, the auxiliary SX file was used to enlarge the coronal one-third of the canal and relocate the canal orifice away from furcal danger zones. The S1 and S2 which were taken to full WL, are mainly designed to prepare the coronal two-thirds of the canal. The shaping of the apical one-third of the canal can be accomplished with the finishing files F1 and F2, whose tip diameters correspond respectively with ISO sizes 20 and 25.

Instrumentation was considered complete when a #25 K-file (Dentsply Maillefer, Ballaigues, Switzerland) reached working length. All stages of the study were performed by one practitioner. Rotation time of each file in the canal was 5 to 10 seconds.

The muffle system was disassembled again and the post-instrumentation photographs were taken. In the final stage, pre- and post-instrumentation photographs were evaluated using image-editing software (Photoshop 6), and canal centering was measured with the Garip method[19,20] as follows (see Figs 1 and 2).

X1: Preoperative distance between canal margin and tooth border on the inner wall of the root curvature.

X2: Postoperative distance between canal margin and tooth border on the inner wall of the root curvature.

Y1: Preoperative distance between canal margin and tooth border on the outer wall of the root curvature.

Y2: Postoperative distance between canal margin and tooth border on the outer wall of the root curvature.

If the quotient equaled one, the canal centering did not change, but for a quotient above one, the canal was transported to the inner wall of the curve; a quotient below one shows transportation to the outer wall of the root curvature.

In this study, each millimeter of transportation in actual size equaled 26.6 units in Photoshop measurement. The data was analyzed using SPSS (SPSS Inc., Chicago, IL, USA), a statistical analysis program. Repeated measurement and independent t-test provided statistical analysis of canal transportation. The level of significance was set at $p < 0.05$.

RESULTS

Table 1 shows the mean and standard-deviation values for electric torque-control motors and air-driven handpieces in 2, 6 and 10 mm root cross-sections.

At 2 mm from the apex, more than 69% of group 1 (electric motors) and 54% of group 2 (air-driven handpieces) had aberrations less than 1 unit (unit is equal 2.66 mm); however, there was no significant difference between the two groups ($p = 0.62$). The most amount of transportation occurred in the 10 mm of apex in group 1 and 6 mm of apex in group 2 in the outer wall of the curvature.

In sections 6 mm of apex, aberrations in the outer wall were less in group 1 than group 2, but without significant differences ($p = 0.28$). In sections 10 mm of apex, 46% of both two groups had aberrations in outer wall without significant differences between the two groups ($p = 1$). There were no significant differences in all sections of the two groups.

DISCUSSION

Root canal preparation has two objectives: Thorough debridement of the root canal system and the specific shaping for obturation.[21] Instrumentation of curved canals can be difficult, leading to canal aberrations, such as zips, ledges and perforation.[22] In narrow and curved canals, more flexible files made of nickel-titanium alloy have been efficient in minimizing mishaps during preparation.[23]

Table 1: Mean and standard-deviation values of canal transportation for electric torque-control motors and air-driven handpieces in each section

Root cross-section level	*Electric torque-control motor (group 1)*		*Air-driven handpiece (group 2)*	
	Mean	*SD*	*Mean*	*SD*
2 (mm)	4.84	2.20	4.86	2.29
6 (mm)	5.76	2.08	6.35	2.24
10 (mm)	6.17	1.76	5.83	2.39

NiTi alloy has a few advantages over stainless steel, such as flexibility, shape memory and resistance to torsional fracture.[24] NiTi rotary instruments produce a better centered canal preparation and can prepare canals more rapidly than the stainless steel K-file.[25] These rotary NiTi files should be used with electric low torque control motors to reduce fracture rate.[13] In electric torque control motors, speed and torque of each instrument is adjustable according to the manufacturer's guidelines.[26] Several studies evaluated instrument fracture rate in electric high- and low-torque control motors.[12,13,26-29]

Gambarini et al studied the effects of electric high- and low-torque control motors on fracture rate and fatigue of NiTi rotary files and indicated that endodontic motors with lower torque values causes lower cyclic fatigue in NiTi rotary instruments.[14] Bortnick et al compared the frequency of instrument separation and/or distortion while using electric and air-driven handpieces with rotary instruments and showed no significant difference in file breakage or distortion regarding Air-driven or electric handpieces.[27] Schafer et al evaluated the shaping ability of rotary FlexMaster NiTi instruments in curved canals, when set into permanent rotation with three different torque limited automated devices and found no significant difference between devices in canal shaping indicated that handpieces with torque-limited rotation are helpful in preparing curved canals.[11] But, no study compares electric and air-driven handpieces in canal transportation as does the present study.

In our study roots with curvatures above 35° were discarded because of torsional and flexural metal fatigue that predispose files to fracture.[28,30]

Schafer found that the mean curvature of mesial canals of mandibular molaris 25°; thus, these teeth were selected for research.[31] Several methods such as impression, radiography, and CT scan were used in previous studies to estimate canal transportation after instrumentation.[32] Because of low accuracy of radiography and impression methods and high cost in CT scan technique, the muffle system was employed. The results of this study indicated that in 2, 6 and 10 mm of apex, there was no significant difference between electric motors and air-driven handpieces.

The results of this investigation and the effects of torque and force on canal transportation align are in agreement with previous studies by Schafer,[11] and Suffridge that showed there was no difference in cleaning ability between torque control and no torque control handpieces[33] although these studies evaluated electric motors and did not examine air-driven handpieces.

Yared et al[26] whom showed that electric high torque control motor is safe, Burklein and Gambarini,[35] showed that lower torque values reduced cyclic fatigue,[14] supported the effect of torque on fracture rate of rotary NiTi files. In addition, Calberson,[4] Zhu,[36] Rangel[37] Yong,[38] Peters,[34] Xu,[39] and Yun,[40] confirmed the effect of file type on canal shape and aberration.

There are obvious differences in canal transportation among various NiTi rotary files.

The results of this study did not confirm the effect of torque on canal transportation, so it can be concluded that force and speed of rotation have not a significant effect on canal transportation.

Therefore, if heavy forces are applied to instruments, they will separate in the canal. In other words, torque of rotation does not transport the canals. The main factor in canal transportation and aberration is the design of the instrument, such as its cross-section and taper.

CONCLUSION

Within the limitations of the present study, the use of NiTi rotary instruments with electric motors or air-driven handpieces does not have an influence on canal anatomy.

CLINICAL SIGNIFICANCE

NiTi rotary instruments can be used with air-driven motors without any considerable changes in root canal anatomy, however it needs the clinician to be expert.

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