

ORIGINAL RESEARCH

Comparative analysis of shaping Effects of different nickel-titanium rotary endodontic file systems

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ABSTRACT:

Background: The introduction of nickel–titanium (NiTi) alloys in the late 1980s led to a revolution in endodontics as these files were shown to have considerable advantages over stainless steel (SS) files, especially in relation to the safety of instrumentation. Nickel-titanium engine-driven rotary instruments are used increasingly in endodontic practice. Due to their flexibility, coupled with the design of the blades, it is feasible to use nickel titanium instruments with a handpiece in a rotary motion to prepare root canals.

Aim of the study: To compare shaping Effects of different nickel-titanium rotary endodontic file systems. **Materials and methods:** The present study was conducted in the Department of Endodontics of the Dental institution. For the study, 90 freshly extracted human permanent mandibular first molars were selected and were kept in normal saline until used. After the preoperative radiograph, the specimens were randomly divided into three groups. Group I: canals prepared with ProTaper, Group II: canals prepared with RaCe, and Group III: canals prepared with Varitaper. All canals were prepared by a single experienced operator. Assessment of the canal preparation, Straightening: - was determined by the change of curvature of pre and post instrumentation images, Cross-sectional area: each section was measured both before and after instrumentation, Transportation: was determined by measuring the shortest distance from the edge of uninstrumented canal to the periphery of the root (mesial and distal) and then comparing this with the same measurements obtained from the instrumented images. **Results:** In the present study, a total of 90 teeth were studied. We observed that group 1, 2 and 3 showed 6.24, 5.81 and 5.69 degrees of straightening, respectively. It was observed that mean transportation at coronal level was seen to be highest for group 1 and lowest for group 3. Similar trend was seen for middle and apical level. **Conclusion:** Within the limitations of the present study, it can be concluded that the removal of dentin was more with ProTaper at coronal and middle Portions than Race and Varitaper instruments. Furthermore, canal prepared with ProTaper had some straightening than RaCE and varitape.

Keywords: NiTi rotary files, endodontic treatment, shaping effect, instrumentation

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INTRODUCTION

The introduction of nickel–titanium (NiTi) alloys in the late 1980s led to a revolution in endodontics as these files were shown to have considerable advantages over stainless steel (SS) files, especially in relation to the safety of instrumentation. ¹ NiTi files were able to overcome the issue of rigidity and low resistance to cyclic fatigue associated with stainless steel instruments. Other than the advantage of increased flexibility and shorter treatment time, NiTi wires also resulted in fewer procedural errors such as zipping, ledges, or transportation due to their superelasticity, compared with SS files. ^{1, 2} Nickel-titanium engine-driven rotary

instruments are used increasingly in endodontic practice. ³ Due to their flexibility, coupled with the design of the blades, it is feasible to use nickel titanium instruments with a handpiece in a rotary motion to prepare root canals. ⁴ Flexibility is conferred by the pseudo-elastic behavior of the SMA (Shape Memory Alloys, to which the Ni-Ti alloy belongs. ⁵ The superelasticity of the material allows the NiTi rotary instruments to be used in continuous rotation, even in curved root canals, to produce a desirable, tapered root canal form, with a low risk of transporting the original canal lumen. ^{5, 6} Hence, the present study was conducted to compare shaping

Effects of different nickel-titanium rotary endodontic file systems.

MATERIALS AND METHODS

The present study was conducted in the Department of Endodontics of the Dental institution. The ethical clearance for the study was approved from the ethical committee of the hospital. For the study, 90 freshly extracted human permanent mandibular first molars were selected and were kept in normal saline until used. The canals were controlled for apical patency with ISO no 10 k -files Only teeth with fully formed root apices and those whose canal width near the apex was approximately size 15 were included, this was evaluated with size 15 K-file. In each tooth specimen any one canal of the mesial root was standardized to 12 mm length by removing the crown using diamond discs (0.3mm). Working length was established at 9 mm, and was determined by subtracting 0.5 mm from the length at which the tip of a size 15 file could be visualized at the apical foramen viewed under a stereomicroscope. After sealing the apices with wax, the canals were mounted in the muffle-block using self cure acrylic resin. After complete polymerization of the resin, the block was removed from the model, the wax removed and the apical foramen exposed. The blocks were sectioned horizontally at three sites (coronal, middle and apical) by a thin cutting disk (0.3-mm thick) mounted on a special machine (Cutty, Manfredi, Italy) for cutting the blocks. Standardized radiographs were taken prior to instrumentation with the file size #10(Dentsply Maillefer, Ballaigues, Switzerland) inserted into the buccal or lingual canal in order to determine the degree of the curvature using periapical Kodak Insight films (Eastman Kodak Company, Rochester, NY). The X-ray tube (Siemens, Heliodont, Germany) was aligned perpendicular to the root canal. The degree of canal curvature was obtained with computer program Motic images 2000, 1.3 (Motic China Group LTD). The degree of curvature was determined according to Schneiders (1971) technique, and angle ranged between 15-300 were included. After the preoperative radiograph, the specimens were randomly divided into three groups.

- Group I: canals prepared with ProTaper
- Group II: canals prepared with RaCe
- Group III: canals prepared with Varitaper

All canals were prepared by a single experienced operator. Preparation was completed in a crown-down manner according to manufacturers’ instructions using a brushing technique. Each instrument was used to enlarge five canals only and then discarded. After preparation, standardized radiographs were taken in the same previous position with the master instrument in-situ using X-ray platform. Curvatures of the prepared canals were

computed and were compared with the previous ones. One blind examiner evaluates the specimens root curvatures. After instrumentation, all sectioned canals were separated, and then photographed in the same manner as pre-treatment photographs. The shaping ability of the rotary instruments was evaluated using the computer program Motic images 2000, 1.3(Motic China Group LTD).

Assessment of the canal preparation

1. Straightening: was determined by the change of curvature of pre and post instrumentation images.
2. Cross-sectional area: each section was measured both before and after instrumentation.
3. Transportation: was determined by measuring the shortest distance from the edge of uninstrumented canal to the periphery of the root (mesial and distal) and then comparing this with the same measurements obtained from the instrumented images.

The statistical analysis of the data was done using SPSS version 11.0 for windows. Chi-square and Student’s t-test were used for checking the significance of the data. A p-value of 0.05 and lesser was defined to be statistically significant.

RESULTS

In the present study, a total of 90 teeth were studied. Teeth were randomized into three groups with 30 teeth in each group. Table 1 shows the mean degree of straightening among groups. We observed that group 1, 2 and 3 showed 6.24, 5.81 and 5.69 degrees of straightening, respectively. The results were statistically non-significant (p>0.05). Table 2 shows mean transportation at coronal, middle and apical level for different groups. It was observed that mean transportation at coronal level was seen to be highest for group 1 and lowest for group 3. Similar trend was seen for middle and apical level. On comparison of mean transportation at coronal, middle and apical level, the highest value was seen at coronal level. The results on comparison were statistically non-significant. [Fig 2].

DISCUSSION

In the present study, we observed studied ProTaper, RaCe and Varitaper in 90 teeth, grouped randomly into 3 groups with 30 teeth in each group. The shaping effect of three NiTi rotary systems were evaluated by degree of straightening and transportation at coronal, middle and apical level. We observed that group 1, 2 and 3 showed 6.24, 5.81 and 5.69 degrees of straightening, respectively. The results were statistically non-significant.

Table 1: Mean degree of straightening among groups

Group	Group	N	Mean	p-value
Group 1	Group 1	30	6.24	0.29
Group 2	Group 2	30	5.81	
Group 3	Group 3	30	5.69	

Fig 1: Mean degree of straightening

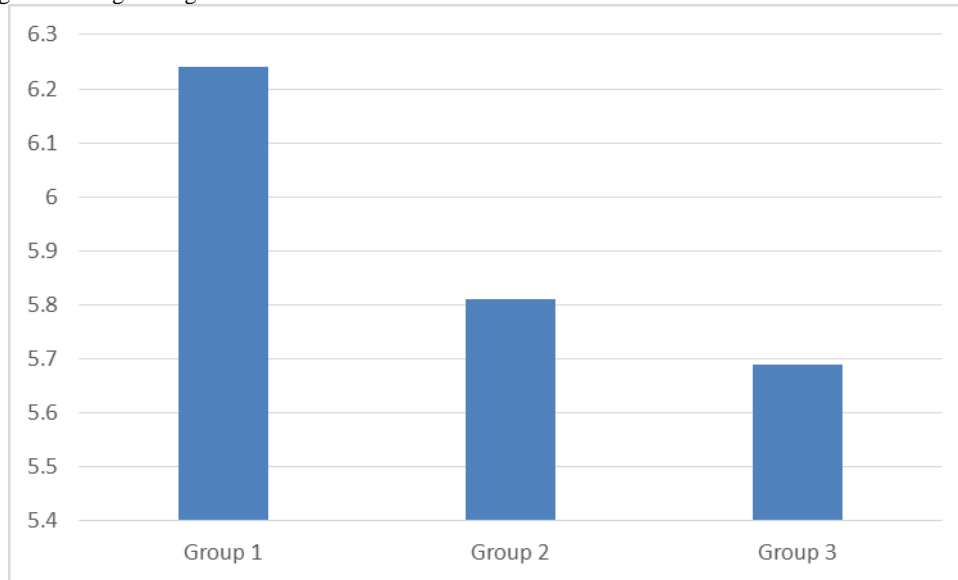
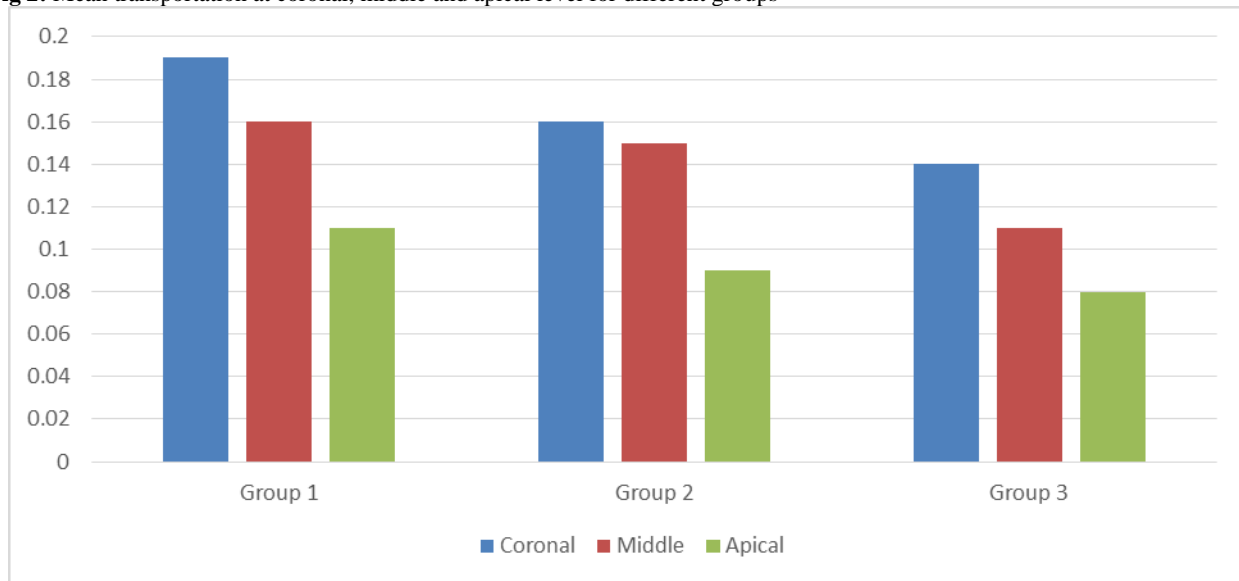


Table 2: Mean transportation at coronal, middle and apical level for different groups

Group	Coronal	Middle	Apical	p-value
Group 1	0.19	0.16	0.11	0.23
Group 2	0.16	0.15	0.09	
Group 3	0.14	0.11	0.08	

Fig 2: Mean transportation at coronal, middle and apical level for different groups



The mean transportation at coronal level was seen to be highest for group 1 and lowest for group 3. Similar trend was seen for middle and apical level. On comparison of mean transportation at coronal, middle and apical level, the highest value was seen at coronal level. The results on comparison were statistically non-significant. The results were compared with previous studies from the literature. Khoshbin E et al⁷ compared Neolix and Reciproc, Mtwo and ProTaper in terms of dentinal crack formation in root canal walls. This in vitro study was conducted on 110 extracted human single-rooted teeth. The teeth were randomly divided into four experimental groups (n=25) for root canal preparation with Neolix, Reciproc, Mtwo

and ProTaper systems and two control groups (n=5). No crack was found in the control groups. All rotary systems caused dentinal cracks. ProTaper, Reciproc, Mtwo and Neolix caused cracks in 92%, 80%, 68% and 48% of samples. ProTaper caused significantly more cracks than Neolix and Mtwo. No significant differences were noted between other groups. They concluded that all rotary systems cause dentinal cracks and it is significantly different in apical, middle and coronal third of the root. Ba-Hattab RA et al⁸ compared the shaping ability of two rotary nickel-titanium systems manufactured from different NiTi wires. Twenty simulated root canals each with a curvature of 35° in resin blocks were divided into

two groups of 10 canals each. Images were taken before canal preparation and after the use of each instrument. They report that HyFlex@CM™ instruments remained better centered in the apical third of the canals. In most canal segments, no significant differences were observed between either system in the amount of material removed. Both systems were comparable to each other in regards to their ability to enlarge root canal in the same way without procedural errors.

Cecchin D et al⁹ evaluated the cutting efficiency of rotary nickel-titanium (NiTi) instruments K3, NiTi Tee, Profile, and Quantec with taper size 04/25. The number of samples was 10 for each group. The analysis of variance (ANOVA) showed that there was a statistically significant difference among the studied groups. The Tukey's test showed that the acrylic resin blocks prepared with instruments K3, NiTi Tee, and Profile presented the greatest mass loss, showing no statistically significant difference among them. The lowest mass loss was found in the blocks prepared with Quantec instruments. They concluded that the K3, NiTi Tee, and Profile instruments presented a greater cutting efficiency than the Quantec instruments. Deepak J et al¹⁰ compared the effects of fifth generation rotary systems on canal curvature, transportation and centering ratio of curved mesial root canals of mandibular molar via cone-beam computed tomographic (CBCT) imaging. With curvature ranging from 20° to 40°, 60 mandibular first molars with mesiobuccal root angle were divided into three groups with 20 canals each. The RS system maintained better canal centricity and less transportation as compared to PTN and OS. There was no significant difference among the three groups in canal curvature after instrumentation. They concluded that all file systems used straightened the root canal curvature similarly. RS instrumentation exhibited superior performance compared with the OS and PTN systems with respect to transportation and centering ratio.

Maitin N et al¹¹ analysed shaping ability of four different rotary endodontic instruments using spiral computed tomography (CT). Eighty freshly extracted human mandibular first molars were used in the present study. Samples were randomly divided into four experimental groups with twenty samples in each group. Images of mesiobuccal canal of each sample were obtained pre- and post-operatively using spiral CT. All samples were prepared using their respective endodontic file systems (group I - ProTaper, group II - K3, group III - RaCe, and group IV - Mtwo). There was no statistically significance in transportation in their intergroup difference at any of the three locations (coronal, middle, and apical third). In centering ability there was no statistically significance in the coronal and middle third of the intergroup. However, there was a statistically significance of at the apical third between all the groups.

CONCLUSION

Within the limitations of the present study, it can be concluded that the removal of dentin was more with ProTaper at coronal and middle Portions than Race and

Varitaper instruments. Furthermore, canal prepared with ProTaper had some straightening than RaCe and varitape.

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