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Original Article

Shaping Ability of Three Ni-Ti Rotary Systems in Curved Root Canals of Extracted Teeth

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ABSTRACT

Aims. The purpose of this study was to compare the effects of 3 different rotary Ni-Ti instruments used to prepare curved root canals on the root canal curvature by using Digora system. **Methods**. Mesiobuccal canals of 30 mandibular first molars with curvature between 20-40 degrees were divided into 3 equal groups according to Ni-Ti rotary system need for root canal preparation: Alpha, RaCe and ProTaper system. Root canal curvatures from both buccal and proximal view were measured before and after instrumentation by using Digora system and image analysis software according Schneider's technique. **Results**. The result indicated that ProTaper system showed significantly greater decrease in curvature in the mesio-distal view and in the bucco-lingual view ($p<.05$). **Conclusion**. The current study concluded that the rotary Ni-Ti RaCe system better maintained the original root canal curvature than the rotary Ni-Ti Alpha System and ProTaper Universal Systems. It may be better to use the rotary Ni-Ti RaCe system to prepared curved canal in order to maintained the original root canal curvature.

Keywords: Shaping Ability, Ni-Ti Rotary Systems, Root Canal Curvature, Digora System.

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INTRODUCTION

One of the main objectives of root canal preparation is to shape and clean of root canal system effectively with maintaining original configuration without creating any iatrogenic event such as instrument fracture, ledge, perforation, however in particular when used in severely curved canal, traditional stainless-steel instrument often fails to achieve the tapered root canal shapes needed for adequate cleaning and filling [1]. In this regard, the introduction of nickel-titanium (NiTi) rotary instrumentation has not only enabled easier and faster instrumentation of the root canal system but also has provided consistent, predictable, and reproducible shaping with considerably less iatrogenic damage [2-4]. In the past few years, advanced instrument designs including non-cutting tips, radial lands and varying tapers have been developed to improve the safety of preparation, to shorten working time and create a greater flare within the preparations [5-7]. Numerous studies have shown the ability of rotary Ni-Ti systems to

maintain the original root canal curvature well [4,5,8,9].

During the last few decades, a number of methodologies have been described to evaluate endodontic instrumentation, including plastic models, histologic sections, scanning electron microscopic studies, serial sectioning, radiographic comparisons, and silicone impressions of instrumented canals. All the above methods have been successfully for many years. However, a number of inherent limitations have been identified. Furthermore, as of today, direct digital systems for intraoral radiography (Digora system), have become established modalities in endodontic research.

The purpose of this study was to compare the effect of three different rotary Ni-Ti systems on maintenance of the root canal curvature by using Digora system.

METHODS

Specimen Preparation

Thirty extracted periodontally involved mandibular first molars were used in the study. Inclusion criteria stipulated that the teeth had curved mesial roots with two distinct, separate canal and portal of exit. Tissue fragments and calcified debris were removed from teeth by scaling, and the teeth were stored in 10% formalin solution. Standard access cavities were made for all teeth, and distal roots of all teeth were separated. Each root canal was negotiated by a no. 10 hand-held stainless-steel file. Only molars within average working length of 20-22 mm were used. The teeth were mounted into the mould with acrylic resin. Root canal curvatures were measured as described by Schneider's (10) from preoperative radiographs after inserting a size 10 k-file. Teeth were divided into 3 equal groups (n= 10 each) according to the instrument used to prepare the mesiobuccal root canals. Group I used Alpha system (Komet, Lemgo, Germany). In group II, canal preparation was carried out by RaCe system (FKG Dentaire, La Chaux-de-Fonds, Switzerland.). While in group III, ProTaper system (Dentsply Maillefer, Ballaigues, Switzerland) were used for preparation. Root canal preparation with NiTi rotary systems was carried out in strict accordance with manufacturer's recommendations. Electric motor with torque control (X-SMART; Dentsply) was used with NiTi systems. Each instrument was coated with RC Prep (Premier Products, Plymouth Meeting, and PA) as lubricant. Irrigation was performed with 10 mL 2.5% NaOCl after each file. Canal patency was performed with no. 10 K-file for each canal. One set of instruments was used for preparation of 5 canals for rotary systems. Canal preparation was completed with master apical file size 25 in all groups because the largest Alpha File (yellow sequence) is size 25 at the tip, and the master apical size should be uniform in all groups.

Image Analysis

Maintenance of root canal curvature was evaluated. Pre- and post-operative radiographs with a size 10 k-file were taken from buccal and proximal views and the root canal curvature in MD and BL direction according to Schneider's technique was determined. The imaging was performed by using a Trophy X-Ray machine with exposure parameters; 60 Kvp, 10 mA and 0.02 second exposure time. Images were captured using the standardized paralleling technique by the XCP alignment system and the large 3×4cm imaging plate. The images were digitized by the Digora system and analyzed using the Digora software package.

Measurement of Root Canal Curvature

The vertical angulations of each canal were determined by tracing a straight line on image parallel to the long axis of the canal, using the mouse pointer, through the outline of the file in the coronal one third of the root. Another line was traced with the mouse pointer from the apical foramen to intersect the first line at the point where the canal began to leave the long axis of the root. The point of intersection of these two lines formed an interior angle was represented canal curvature, the value of which was presented in the corresponding location in the measurement box.

Statistical Analysis

Data were presented as mean and standard deviation values. One-way analysis of variance (ANOVA) was used for comparison between means. The Tukey post hoc test was used for pairwise comparison between the means when ANOVA test was significant. The significance level was set at $p \leq 0.05$.

RESULTS

Distribution of preoperative root canal curvatures

The mean preoperative root canal curvature from buccal view was 26.87° ± 6.8 in the Alpha, 26.86° ± 4.8 in the RaCe and in the ProTaper group 25.15° ± 5.3, whereas for proximal view was 18.03° ± 4.5 in the Alpha, 18.39° ± 5.8 in the RaCe and in the ProTaper group 16.28° ± 6

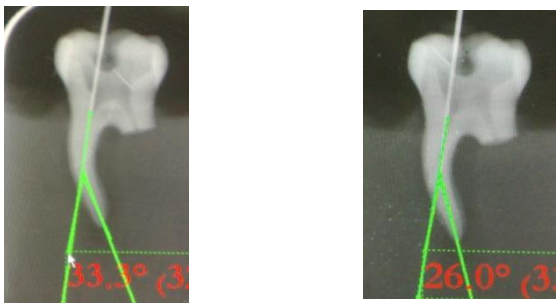
Straightening

The mean straightening after preparation to size 25 from buccal view was 15.6° ± 5.6 in the Alpha, 7.68° ± 3.7 in the RaCe and in the ProTaper group 25.85° ± 12. While from proximal view was 18.07° ± 10 in the Alpha, 10.51° ± 6.8 in the RaCe and in the ProTaper group 26.65° ± 6.9. The Tukey test results showed that there were statistically significant differences between the 3 groups from both buccal and proximal view (each view separately). Group III showed the statistically significantly highest mean percentage of changes. Group II showed the statistically significantly lowest mean percentage of changes (Table 1, Fig. 1).

Table 1. Mean percentage of changes in root canal curvature in MD and BL direction.

	I (Alpha system)		II (RaCe system)		III (Pro Taper system)		*P*-value
Group Direction	Mean	SD	Mean	SD	Mean	SD	
MD	15.6 [b]	5.6	7.68 [c]	3.7	25.85 [a]	12	<0.001*
BL	18.07 [b]	10	10.51 [c]	6.8	26.65 [a]	6.9	0.001*

[a,b,c]Means with different letters are statistically significantly different according to Tukey's test. *Significant at P≤ 0.05.



(A) (B)

Fig. (1): A photograph of the digitized image for measuring root canal curvature in Mesio-Distal direction using Schneider's techinque. (A) Pre-operative and (B) Post-operative.

DISCUSSION

The introduction of rotary Ni-Ti instruments in endodontics instead of stainless-steel instruments facilitates effectiveness and speed of cleaning and shaping procedures even in most severe canal curvature [11]. Several investigations have shown the ability of some new rotary Ni-Ti system to maintain the original root canal curvature [5] and other studies shown that rotary Ni-Ti instruments allow for a more rapid, centered, rounder and conservation of shape compared to stainless steel files [11]. Direct digital systems for intraoral radiography have been available since the late 1980s and were based on charged-coupled device systems. A more recent development is the Digora system [12] was applied in this study to compare the effect of 3 different rotary Ni-Ti systems on maintenance of the root canal curvature; it allows the clinician to adjust contrast and magnification. It also offers the possibility of quantifying the distance between two points on a given image to a tenth of millimeter. Furthermore, it is a reproducible and reliable method in assessing geometric (linear and angular) measurements from serial radiographs [13].

The mesiobuccal canals of the human lower first mandibulare molar were selected for their wide range of curvature that could be used for evaluation of the preparation which was similar to the clinical situation [1,3,8,14-19].

During selection of samples, choosing teeth exhibiting curvatures within specified ranges in between (20-40 degrees) appeared to be more relevant to the clinical situation [8,14,20,21]. Schneider's method was used being a simple method to evaluate changes in curvature of the canals, also for its accuracy and reliability [3,8,17,19,22].

The results showed that there is a statistically significant difference between the 3 groups in regard to percentage of changes in root canal curvature in the mesio-distal view and in the bucco-lingual view. A significantly greater decrease in curvature was recorded in the groupIII than in the other groups. The current results were in agreement with previous studies which attributed that to the fact the ProTaper instruments are thicker than the RaCe and Alpha Files at the same level causing more widening of the canal thus resulting in decreasing the canal curvature Yun and Kim [23]. It could also be attributed to the variable tapers along the cutting surfaces of the ProTaper files in combination with their sharp cutting edges as well as the decreasing taper sequence of the finishing files that enhances the strength of the file but at same time it increases its stiffness Schafer and Vlassis (24). Also, these results come in agreement with [22,25-27] where it was stated that ProTaper with its convex triangular cross-sectional produced more straightening of curved canals. Also, we found that RaCe System better maintaining the root canal curvature. This result was in full agreement with Schafer and Vlassis [1,8,22,24,25,28].

CONCLUSION

Under the condition of the present study, we concluded that the rotary Ni-Ti RaCe system better maintained the original root canal curvature than the rotary Ni-Ti Alpha System and ProTaper Universal Systems. It may be better to use the rotary Ni-Ti RaCe system to prepared curved canal in order to maintained the original root canal curvature. Moreover, It may be better to use the rotary Ni-Ti ProTaper system in combination with other less tapered and more flexible instrument in order to preserve the dangerous zone of curved root canal.

Disclaimer

The article has not been previously presented or published and is not part of a thesis project.

Conflict of Interest

There are no financial, personal, or professional conflicts of interest to declare.

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