BAU Journal - Creative Sustainable Development

Volume 2 | Issue 2
ISSN: 2664-9446

Article 12

May 2021

MAINTAINING ROOT CANAL CURVATURES AFTER PREPARATION WITH DIFFERENT NICKEL-TITANIUM ROTARY SYSTEMS (A COMPARATIVE IN VITRO STUDY)

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Endodontics, Root canal preparation, curved root canal, maintaining canal curvature, instruments, TwoShape, ProTaper Next.

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Abstract

The ongoing advancement of materials and methods for root canal instrumentation is resulting in improved techniques with minimal variations to the canal morphology. One standard for assessment of the shaping quality of curved root canals is preparation-induced straightening of the canal. The aim of the study: To compare the effects of 2 Nickel-Titanium rotary systems, 2Shape (Micro-Mega, Besançon, France) and ProTaper Next (Dentsply,Sirona, Ballaigues, Switzerland), on maintaining the distobuccal canals curvature of extracted human maxillary molar teeth using periapical radiographs. Materials and methods: In this study a total of 26 distobuccal roots of upper maxillary molars were used and divided into 2 groups: Group 1 (n=13) root canals prepared with 2Shape system (TS1, TS2) (Micro-Mega, Besançon, France) and Group 2 (n=13) root canals prepared with ProTaper Next (X1, X2) (Dentsply,Sirona, Ballaigues, Switzerland). A buccolingual radiograph was taken for every sample before and after instrumentation in the same position, and the postoperative angle of curvature was measured with the Image J Software and the same principle of the method of Schneider. The post instrumentation curvature degree was subtracted from the pre instrumentation curvature degree and these results represented the degree of straightening. Result: P< 0.05 was significant for ProTaper Next and 2Shape. 2Shape respected better the curvature angulations than ProTaper Next. Conclusion: Selection of the instruments has an important influence on the respect of the root canal curvature angulations.

Keywords

Endodontics, Root canal preparation, curved root canal, maintaining canal curvature, instruments, TwoShape, ProTaper Next.

1. INTRODUCTION

The effective endodontic treatment depended mainly on thorough shaping and cleaning of the root canals (Weine, F. S. 1996, Gulabivala, K., and al. 2005). A primary goal of shaping was to maintain the original direction and outline of the root canal. However, in curved canals, this was difficult because of all the techniques used for canal preparation tended to divert the canal away from its axis and change the canal curvature (Abou-Rass, M., and al. 1980). The aim of root canal instrumentation is to form a continuously tapered shape with the smallest diameter at the apical foramen and the largest at the orifice to allow effective irrigation and filling (Schilder, H. 1974). This procedure should be carried out without any deviations from the original trajectory, in curved and thin canals, (Hata, G. I., and al. 2002) using techniques and instruments which have the greatest precision and the shortest working time. (Iqbal, M. K., and al. 2003) The purpose of studies analyzing post-operative root canal shape is to evaluate the conicity, taper, and flow of the prepared root canal, and maintenance of the original canal shape. The ability of an instrument or a technique to allow the prepared canal to stay centered is seen as a positive aspect. Conversely, canal transportation and preparation errors are considered a negative aspect. (Peters, O. A. 2004)

Changing the curvature of the canal resulted in more incidences of the ledge, canal transportation, elbow formation, zip, and stripping (Abou-Rass, M., and al. 1980). These difficulties in the preparation of curved canals had prompted the manufacture of new instruments preparation methods (Hankins and al. 1996). The American Endodontists Association defined transportation as the canal wall structure removal on the outside curve in the apical half of the canal due to the files tendency to restore themselves during canal preparation to their original linear shape (American Association of Endodontists, 2003). The manufacturing of nickel-titanium (NiTi) rotary instrumentation had transformed the root canal treatment by reducing the errors associated with root canal preparation and the time needed to finish the preparation (Park, H. 2001). Different NiTi file systems had different features such as the taper, number of spirals or flutes, depth of flutes and cross-sectional design (García, M., and al. 2012). Knowledge of the complex tooth internal anatomy and careful planning of endodontic treatment are mandatory to reduce failure rates. Periapical radiography is an essential resource in endodontic diagnosis. However, periapical radiographs are two-dimensional representations of three-dimensional structures and certain clinical, morphological, and biological features may not be reflected in radiographic changes. (Estrela, C., and al. 2008). Several studies have determined the curvature of the root canals by the angle and the radius methods (Lopes, H. P., and al. 1998, Moreira, et al 2002, Schäfer, E., and Florek, H. 2003) using periapical radiographic images.

It is well known that when curvatures are present, endodontic preparation becomes more difficult, and there is a tendency for all preparation techniques to divert the prepared canal away from the original axis. (Javaheri, H. H., and Javaheri, G. H. 2007). The morphology of a curved root canal is of great importance to the outcome of root canal instrumentation, with several studies being conducted to describe the curvature (as indicated in Table 1). In 1971, Schneider et al. (Schneider, S. W. 1971) performed pioneering work on measuring canal angulation. The Schneider method (Schneider, S. W. 1971) involves first drawing a line parallel to the long axis of the canal, in the coronal third; a second line is then drawn from the apical foramen to intersect the point where the first line left the long axis of the canal. The Schneider angle is the intersection of these lines. In the past few decades, only the angle of the canal curvature was the focus for categorizing the root canal morphology and the curvature. The canal was classified as either straight (if the angle was 5° or less), moderately curved (if the angle was 10-20), or severely curved (if the angle was >20°). Later, it was proposed that the degree, position, and severity of the canal curvature also play an important role. (Peters, O. A. 2004)

Table 1: Classifications of root curvature

Basis	*Classification*				*Reference*
According to anatomic location	Cervical Curvature (greater than 2.0),	Median Curvature (from 0.5 to 2.0)	Apical Curvature (smaller than 0.5)		*Berbert and Nishiyama 1994*
Radius-based curvature	Severely curved (r<4 mm)	Moderately curved (r>4 mm; <8 mm)	mild curvature (r>8 mm)2		*Backman et al.1992, Southard et al. 1987*
Based on the degree of curvature	Straight (angle is 5°or less)	Moderately curve (angle is 10-20°)	Severely curved (angle is 25-70°)		*Schneider's 1971*
Shape-based curvature	Gradual curve	Sickle-shape curve	Dilaceration	Bayonet	*Ingle and Taintor 1985 Pucci and Reig 1944*
	I shape (straight)	J shape (apical curve)	C shape (entirely curve)	S shape (multi-curve)	*Dobó Nagy et al. 1995*

Nickel-titanium (NiTi) instruments have decrease the tendency for canal transportation and have better centering ability than stainless steel (McSpadden, J. T. 1995) due to their greater elasticity. (Miura, F., and al. 1986) Manufacturers make every effort to improve NiTi instruments by changing their design and enhancing the structural alloy to enhance their mechanical performance. (Walton, R. E., and Fouad, A. F. 2014, Hülsmann, M., and al. 2005, Koch, K., and Brave, D. 2002)

ProTaper Next files (PTN; Dentsply Sirona, Ballaigues, Switzerland) are made of M-wire heat-treated alloy with an asymmetric square cross-section. The ProtaperNext system consists of X1 (17/.04), X2 (25/.06), X3 (30/.07), X4 (40/.06), and X5 (50/.06) files. While the TwoShape (TS; (Micro-Mega, Besançon, France)) is made of T-wire heat-treated alloy with an asymmetric triangular cross-section, and the system is composed of 2 shaping files TS1 (25/.04), TS2 (25/.06), and 2 finishing files to be used when need in large canals F35 (36/.06), and F40 (40/.04) files.

Accordingly, the present study aimed to compare the effects of those 2 Nickel-Titanium rotary systems on maintaining the distobuccal canals curvature of extracted human maxillary molar teeth using periapical radiographs.

2. MATERIALS AND METHODS

Twenty-six extracted human maxillary first molars were used in this study.

Inclusion / exclusion criteria:

The pulp status, gender and the reason for extraction were not considered and the teeth selection was done according to the following criteria: the tooth had completely formed roots and a curved disto-buccal root angleed between 20° and 40°, with patent apical foramen. Roots with cracks, resorptions, or fractures or incompletely formed apices were excluded from the study.

Samples preparation:

The teeth were kept in a solution of thymol at room temperature (Berdan , Tijen , Aysun , Mehmet , & Tugba , 2015). Any calculus and soft tissue remnants were removed from the root surface with a sharp curette. A light cure device and magnifying eye lens used to verify the root surfaces for any visible cracks or fractures. The crown portion and the mesial and palatal roots of all teeth were removed at the cementoenamel junction level by the application of diamond disc bur in a straight high-speed handpiece with water coolant, the remaining distobuccal part was adjusted coronally with the same bur to standardize the working length of all teeth at 18 mm. Only the distal canals were used in this study.

For standardizing the before and after preparation radiographs, roots were maintained in the wax and radiographs were taken with the digital radiograph of the Lab with Sopix Software. The exposure time was 0.12 second.

These radiographic images were used to measure the roots canal curvature before instrumentation by using the Image J Software according to Schneider's technique, (Schneider, S. W. 1971) where canal curvature was obtained by drawing a straight line along the root canal longitudinal axis in the coronal third and a second straight line from the root foramen to intersect with the first line at the point where the canal begin to drift from the tooth long axis. This technique gives the deflection angle between the intersecting lines.

After this, samples were randomly divided into two groups according to the preparation instrument: Group 1 (n=13), root canals were prepared with 2shape system (TS1, TS2) (Micromega, Besançon, France) at 400 RPM and a torque of 1.2 Ncm. In Group 2 (n=13), root canals were prepared with ProTaper Next (X1, X2) (Dentsply,Sirona, Ballaigues, Switzerland), at 300 RPM and a torque of 4 Ncm. Each instrument was used only one time. Before root canal preparation K file 10 and 15 were introduced before shaping as glide path and checking the patency of the root canal by using 2.5% of NaOCl for irrigation. After instrumentation, the final rotary file of each system with tip size 25 was introduced into the canal to full working length.

Then, each tooth was radiographed from the buccolingual view in the same position as in pre-instrumentation radiographs and the postoperative angle of curvature was measured with the Image J Software using the same Schneider technique, previously prescribed. The difference between the original degree of canal curvature and after instrumentation gave the reduction in the degree of curvature of the canals. The post instrumentation curvature degree was subtracted from the pre instrumentation curvature degree and these results represented the degree of straightening. All samples were prepared by one operator, measurements and assessment of the radiographs were done by two operators, and the average of both results was taken as final and sent to statistical analysis.

3. RESULTS

Results of one-sample t-test of the present in vitro study evaluating twenty-six roots treated in two groups ProTaper Next (Dentsply,Sirona, Ballaigues, Switzerland) and 2Shape (Micro-Mega, Besançon, France) were tabulated in tables 2 and 3.
The unit used in tables was the degree. The test used in the SPSS analysis was One-Sample Test.

Table 2: One-Sample Statistics. Reference: Done by the Authors.

	N	Mean	Std. Deviation	Std. Error Mean
ProTaper Next	13	4,0115	4,25797	1,18095
2Shape	13	3,2077	1,87903	,52115

Table 2 showed the following results:

- The average difference between curvature by the system: ProTaper Next was (4,0115) higher than 2Shape with (3,2077)
- The Std. Deviation ProTaper Next was higher than 2Shape
- The Std error by ProTaper Next was also higher than 2Shape.

Table 3: One-Sample Test. Reference: Done by the Authors.

	Test Value = 0					
	T	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
ProTaper Next	3,397	12	,005	4,01154	1,4385	6,5846
2Shape	6,155	12	,000	3,20769	2,0722	4,3432

One sample test (Table 3) showed that 2Shape respected the curvature angulations significantly better than ProTaper Next, with the level of significance being at (P< 0,05)

4. DISCUSSION

In the past, files and reamers were only manufactured from either carbon-steel or stainless-steel. However, it was difficult for the large sizes to negotiate curved canals due to the relatively high modulus of elasticity of these materials. (Ponti, T. M., et al. 2002) William Buehler developed newer instruments made of Nickle Titanium alloy in 1962 that is significantly more elastic than stainless steel. (Buehler, W. J., et al. 1963) In 1988, Walia et al. introduced NiTi for the manufacturing of endodontic instruments. (Walia, H., and al. 1988) Since the introduction of this alloy, a number of different files have been developed from NiTi. Many studies demonstrated that NiTi instruments remain better centered in the canal compared to stainless steel. Esposito and Cunningham (Esposito, P. T., and Cunningham, C. J. 1995) found that instruments larger than ISO size 30, both hand and rotary NiTi files were significantly more effective than SS in maintaining the original path of the canal. Glossen et al. reported similar findings with instruments larger than size 45. (Glosson, C. R., and al. 1995)

Root canal anatomy and the degree of curvature are important elements to be considered for the success in different steps of root canal treatment. Long, narrow, and curved canals are the most susceptible to transportation. Instrument distortion and separation in curved root canals can also cause serious problems during root canal therapy. Hand and rotary instruments are available in various designs that differ in tip and taper design, rake angles, helical angles, pitch and different types of alloys. (Lim, Y. J., and al. 2013)

Numerous studies compared the ability of several new rotary NiTi systems to maintain original canal shape and therefore remain better centered. (Hülsmann, M., and al. 2005, Al-Sudani, D. and S. Al-Shahrani, 2006, Jain, A., and al. 2016)

This study evaluated the difference of root canal curvatures before and after canal preparation with different Nickel-Titanium Rotary systems. Two instruments were used for each system, and the final apical preparation was determined to be size 25. Similar apical preparation diameters are required for the comparison of the shaping and cleaning ability of different root canal instruments. In the present study, we measured root canal curvature on scanned radiographs using a computerized program.

The results of the present study revealed that 2Shape respected better curvature angulations than ProTaper Next. 2Shape is a T-wire alloy and ProTaper Next is an M-wire alloy, both M-wire and T-wire are nitinol after a proprietary thermomechanical processing procedure that increased the flexibility and the fatigue resistance. However, there were some differences in the manufacturing and configurations of the two systems. The reason for using the distal root of first maxillary molar teeth in this study is that it is the mesial root has a high percentage of two canals. The radiographic technique used in this study was easy to use, inexpensive and potentially informative but only used to record two-dimensional changes (Hülsmann, M., et al. 2005). The real changes in curvature are in the three plans. It also used the Schneider technique to measure the angle, however, using Schneider angle with the radius of curvature will only depict the apical geometry of root canals curves and not the coronal part of the root canal. (Sadeghi, S., and Poryousef, V. 2009) Therefore, it would be of clinical interest to investigate the performances and centering abilities of these systems in severely curved canals using three dimensional radiographs.

5. CONCLUSION

Based on the parameters examined in this study and within its limitations, instruments' selection could be of high influence in maintaining root canal curvature.

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