Shaping Ability of NiTi Rotary versus Stainless-Steel Hand Instruments in Curved Root Canals of Extracted Teeth

Original Article

Shiva Sadeghi [1], Elnaz Farhodi [2]

[1] Associate Professor, Department of Endodontics, Guilan University of Medical Sciences Dental School, Rasht, Iran
[2] Dentist, private practice

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Corresponding Author:
Shiva Sadeghi, DDS
Address: Department of Endodontics, Guilan University of Medical Sciences Dental School
Rasht, Iran.

Telephone: +98-131-3263628
Fax: +98-131-3263623
E-mail: Sadeghi.dds@gmail.com

Abstract

Introduction: The purpose of this in-vitro study was to compare shaping ability of NiTi rotary Mtwo and FlexMaster with stainless steel hand K-Flexofile in curved root canals of extracted teeth.

Materials and Methods: Mesiobuccal canals of 45 mandibular molar teeth were balanced into three groups of 15 each, with respect to the Schneider angle, canal access angle, height, distance and radius of canal Curvature. Canals were prepared with Mtwo, FlexMaster and stainless steel hand K-Flexofile according to the manufacturers` instruction. Comparing pre- and post-instrumentation radiographs, straightening of the canal curvatures was determined using AutoCAD program. Data was analyzed using one way ANOVA and Tukey HSD test.

Results: After instrumentation, the K-Flexofile system was significantly different from Mtwo and Flex Master systems for the mean difference of Schneider angle ($p=0.0001$, $p=0.0001$), canal access angle ($p=0.006$, $p=0.003$), radius ($p=0.045$, $p=0.015$) and distance of curvature ($p=0.001$, $p=0.001$).

Conclusion: Mtwo and FlexMaster files maintained the original canal curvatures better than the K-Flexofile

Key words: • Root canal preparation • Dental instruments

Introduction

Cleaning and shaping of the root canal space is a primary objective of root canal treatment. It is important that endodontic instruments remove dentine and pulpal debris from the entire root canal wall uniformly and maintain the original canal curvature. A number of studies have compared shaping ability of NiTi rotary instruments versus stainless steel hand files either in simulated curved canals of resin blocks or in curved root canals of extracted teeth.[1-10] Comparing the shaping ability of different instruments in standardized root canals of resin blocks do not reflect the action of the instruments in root canals of real teeth.[11] Thus, studies using real root canals in extracted teeth are required in order to fully assess the cleaning and shaping efficiency of root canal instruments.[5]

Recently, shaping ability of two new NiTi rotary Mtwo and FlexMaster systems were compared with stainless steel hand K-Flexofiles in simulated curved canals.[3] The primary aim of this in-vitro study was to compare shaping ability of NiTi rotary Mtwo and Flex Master with stainless steel hand K-Flexofile in curved root canals of extracted teeth with a more exact method than generally used in endodontic research. The second aim was to compare shaping ability of NiTi rotary Mtwo with FlexMaster system.

Materials and Methods

A total of 45 curved mesiobuccal canals of extracted mandibular molars were used. After access cavity preparation, patency of the apical foramen was checked and standardized by inserting a size 15 K-file (Dentsply Maillefer, Ballaigues, Switzerland) so that the file tip was just visible. Individual working length (WL) was calculated 0.5 mm short of this position. The crowns were shortened so that the teeth had the same working length of 19±1 mm. Standardized radiographs were taken prior to the instrumentation with a number 15 K-file placed in mesiobuccal canal. The teeth were placed in a wax mould which was attached to a Kodak Ultra-speed film (Kodak, Stuttgart, Germany) and were aligned so that the long axis of the root canal was parallel and as near as possible to the surface of the film. The X-ray tube, and thus the central X-ray beam, was perpendicular to the root canal. The exposure time (0.40 s; 70 kv, 8 mA), source-to-film distance (27 cm) and object-to-film distance (5 mm) was kept constant for all radiographs. The films were developed, fixed and dried in unchanging and standard conditions. The radiographs were scanned (Scanner: Agfa-Duascan, Germany) and all the angular and linear values were plotted using the program Auto CAD 2008.

Canal curvatures were determined in a more exact manner[12] measuring two angles, Schneider angle (S)[13] in combination with canal access angle (CAA)[14] and the related parameters including height (X) and distance (Y) of the canal curvature, and radius of the curvature (R)[15] (Figure 1).

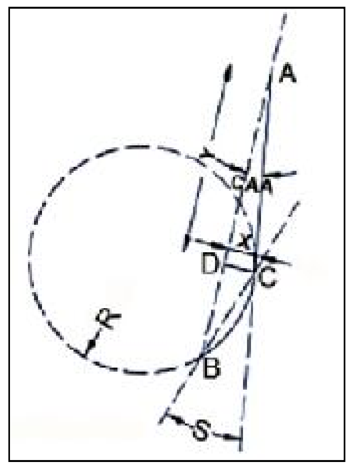

Figure 1. A, Canal orifice; B, apex; C, the point that the canal begins to move away from the long axis; D, the point that the perpendicular line from C intersect line AB; Canal access angle(CAA), the angle between line AB and line AC; Schneider angle (S), the acute angle between line BC and line AC; CD(X), canal height; AD(Y), canal distance; R, radius.[12]

The specimens were divided to create three groups as balanced as possible in terms of these parameters (n=15). The homogeneity of the three groups with respect to these parameters was assessed using one way ANOVA test (Table 1).

Nickel-titanium rotary instruments were used with a 4:1 reduction handpiece (Nakamura, Japan) powered by a torque limited electric motor (Endo IT motor, VDW, Germany). A chelating agent (RC-prep; Dentsply Maillefer, Ballaigues, Switzerland) and NaOCl 2.6% were used to fill the pulp chamber at the beginning of instrumentation. In addition, 5 ml of NaOCl 2.6%was delivered in the pulp chamber after the use of each file for 10 seconds. Each instrument was used to enlarge five canals only. Every five teeth were defined as a set. The order of use of the instruments within a set was rotated. Preparations were completed by an experience operator. To minimize the operator fatigue only five canals were instrumented at a time. All canals were enlarged to an apical size of 30 according to the manufacturer's instructions. The following instrumentation sequence was used with different instruments:

All M two instruments were used to the full length of the canals using a gentle in-and-out motion. The instrumentation sequence was: 10/0.04 (WL), 15/0.05 (WL), 20/0.06 (WL), 25/0.06 (WL), 30/0.05 (WL). Once the instrument had achieved the end of the canal and had rotated freely, it was removed.

All Flex Master instruments were used in a crown down manner using a gentle in-and-out motion. Instruments were withdrawn when resistance was felt and changed for the next instrument: 20/0.06 (one-half of WL) , 30/0.04 (one-half of WL) ,25/0.04 (two-third of WL) ,20/0.04 (WL) ,20/0.02 (WL) ,25/0.02 (WL) ,30/0.02 (WL). Once the instrument had achieved the end of the canal and had rotated freely, it was removed.

K-Flexofile hand instruments (Dentsply Maillefer, Ballaigues, Switzerland) were used in step back manner: 15/0.02 (WL), 20/0.02 (WL), 25/0.02(WL), 30/0.02(WL), 35/0.02 (WL-1),30/0.02(WL),40/0.02(WL-2), 30/0.02 (WL), 45/0.02(WL-3), 30/0.02 (WL).

At the end of canal preparation, the canal curvature parameters were redetermined on the basis of a radiograph with the final root canal instrument inserted into the canal at WL.

Canal straightening was determined as the difference between canal curvature parameters prior to and after instrumentation. One way ANOVA and Tukey HSD test were used for comparison of the three groups. The level of statistical significance was set at $p<0.05$.

Results

During preparation of the 45 canals no instrument separated and no instrument was permanently deformed. The mean values for Schneider and canal access angle, radius, height and distance of curvatures were significantly different among experimental groups after instrumentation ($p<0.0001$, $p<0.0001$, $p=0.005$, $p=0.024$, $p<0.0001$). The mean differences of these parameters before and after instrumentation are shown in Table 2. Tukey HSD test showed that after instrumentation the K-Flexofile system was significantly different from Mtwo and Flex Master systems for the mean difference of Schneider angle ($p=0.0001$, $p=0.0001$), canal access angle ($p=0.006$, $p=0.003$), radius ($p=0.045$, $p=0.015$) and distance of curvature ($p=0.001$, $p=0.001$).

Table1. Characteristic of curved root canals before instrumentation (n=15)

instrument	Schneider angle(o) Mean ± SD	Canal access angle(o) Mean ± SD	Radius (mm) Mean ± SD	Height (mm) Mean ± SD	Distance (mm) Mean ± SD
M two	26.22 ± 7.53	12 ± 4.64	10.24 ±4.36	1.8 ± 0.85	5.23 ± 1.01
Flex Master	28.33 ± 7.37	16.2 ±5.41	8.48 ± 1.97	1.56± 0.43	4.85 ± 1.05
K-Flexofile	27.6± 6.93	14.8 ±5.3	7.8 ±2.96	1.48 ± 0.45	4.36 ± 1.23
p-value*	P=0.084	P=0.084	P=0.119	P=1.102	p=0.107

***ANOVA Test**

Table 2. Difference of characteristic of curved root canals before and after instrumentation (n=15)

	Schneider angle(°) Mean ± SD	Canal access angle(°) Mean ± SD	Radius (mm) Mean ± SD	Height (mm) Mean ± SD	Distance (mm) Mean ± SD
M two	4.53 ± 3.18	5 ± 3.51	2.11±2.49	0.62± 0.33	0.38 ± 0.93
Flex Master	6.86 ± 5.82	4.93 ±4.75	1.28± 1.71	0.56± 0.32	0.75 ± 0.31
K-Flexofile	15.53± 6.98	10.53 ±4.51	6.78± 8.40	0.78 ± 0.37	1.45 ± 0.66
p-value (ANOVA)	P=0.0001	P=0.001	P=0.012	P=0.225	p=0.001

***ANOVA Test**

Discussion

To ensure standardization of the samples, mesiobuccal canals of natural teeth in the experimental groups were balanced with respect to apical diameter, working length and different parameters of the root canal curvature using a computerized digital image processing system in a more exact manner than generally used in endodontic research. 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. CAA together with height and distance of curvature provide more information about the coronal geometry of root canal curvatures. Canals that are measured in this way may have different abruptness of curvature in the apical part of the canal.

Thus, the shape of root canal curve is more accurately described using two angles, Schneider in combination with CAA and the related parameters including radius, length, distance and height of curvature. This combination provides more accurate guidelines for both coronal and apical parts of canal curvature.[12] Furthermore, in this study irrigation procedures, root canal preparation and radiographs were standardized for all experimental groups.

In the present study, shaping ability of the three systems was evaluated based on the canal curvature parameters assessed prior and after instrumentation. According to the results of this study, there was no significant difference between Mtwo and FlexMaster instruments. Both NiTi rotary systems maintained the original canal curvature significantly better than K-Flexofile instruments. This finding is in accordance with all previously published reports showed that rotary instruments provide a better shaping than stainless steel hand k-files in extracted curved canals.[1,5,7,9] However, shaping ability of these instruments in curved extracted human teeth was different from results obtained in resin blocks using the same instruments.[3] One possible reason for these differences may be due to the characteristics of the samples, their surface texture, hardness and cross section.[11] Using rotary instruments in resin blocks generate heat[2] which may soften the resin material and lead to binding of cutting blades[10] and influence shaping ability of these instruments. Other variables such as operators and their experiences, study design and the limitations of the used techniques for evaluating shaping ability of the instruments also should be noted as the possible reasons for different results obtained with the same instruments and techniques.[3]

Conclusion

Under the limitation of the present study, Mtwo and FlexMaster files maintained the original canal curvatures better than the K-Flexofile.

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References

1. Glossen CR, Haller RH, Dove SB, del Rio CE. A comparison of root canal preparations using Ni-Ti hand, Ni-Ti engine- driven, and K-Flex endodontic instruments. J Endod 1995; 21: 146-51.

2. Kum KY, Spängberg L, Cha BY, II-Young J, Msd, Seung-Jong L,et al. Shaping ability of three Profile rotary instrumentation techniques in simulated resin root canals. J Endod 2000; 26: 719-23.

3. Sadeghi S. Shaping ability of NiTi rotary versus stainless steel hand instruments in simulated curved canals. Med Oral Patol Oral Cir Bucal 2011; 16: e 454-8.

4. Schäfer E. Shaping ability of Hero 642 rotary nickel-titanium instruments and stainless steel hand K-Flexofiles in simulated curved root canals. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2001; 92: 215-20.

5. Schäfer E, Erler M, Dammaschke T. Comparative study on the shaping ability and cleaning efficiency of rotary Mtwo instruments. Part 2: Cleaning effectiveness and shaping ability in severely curved root canals of extracted teeth. Int Endod J 2006; 39: 203-12.

6. Schäfer E, Florek H. Efficacy of rotary nickel-titanium K3 instruments compared with Stainless steel hand K-Flexofile. Part 1: shaping ability in simulated curved canals. Int Endod J 2003; 36: 199-208.

7. Schäfer E, Florek H. Efficiency of rotary nickel-titanium K3 instruments compared with stainless steel hand K-Flexofile. Part 2: Cleaning effectiveness and shaping ability in severely curved root canals of extracted teeth. Int Endod J 2003; 36; 208-17.

8. Schäfer E, Lohmann D. Efficiency of rotary nickel-titanium FlexMaster instruments compared with stainless steel hand K-Flexofile. part1: Shaping ability in simulated curved canals. Int Endod J 2002; 35: 505-13.

9. Schäfer E, Lohmann D. Efficiency of rotary nickel-titanium FlexMaster instruments compared with stainless steel hand K-Flexofile. part2: Cleaning effectiveness and instrumentation results in severely curved root canals of extracted teeth. Int Endod J 2002; 35: 514-21.

10. Thompson SA, Dummer PMH. Shaping ability of Profile .04 taper series 29 rotary nickel-titanium instruments in simulated canals. Part 1. Int Endod J 1997; 30: 1-7.

11. Peters OA. Current challenges and concepts in the preparation of root canal systems: a review. J Endod 2004; 30: 559-71.

12. Sadeghi S, Poryousef V. A novel approach for determining root canal curvatures. IEJ 2009; 4: 131-4.

13. Schneider SW. A comparison of canal preparations in straight and curved root canals.Oral surg 1971; 32: 271-275.

14. Gunday M, Sazak H, Graip Y.A comparative study of three different root canal curvature measurement techniques an measuring the canal access angle in curved canals. J Endod. 2005; 31: 766-99.

15. Schafer E, Diez C, Hoppe W, Tepel J. Roentgenographic investigation of frequency and degree of canal curvarures in human permanent teeth. J Endod 2002; 26: 211-216.