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Apical transportation of nickel-titanium rotary Mtwo and RaCe instruments compared with conventional stainless steel hand instruments.

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Abstract

Introduction: Apical transportation is an important iatrogenic damage in endodontics. This study evaluates the transportation caused by two nickel-titanium (NiTi) rotary instruments compared with a stainless steel hand instrument.

Materials and methods: This *in vitro* experimental study was performed on 51 simulated canals with a 40° curvature angle, fabricated within transparent and hard polyester resin. The groups consisted of K-File stainless steel hand-instrument (n=15), RaCe NiTi rotary file (n=18), and Mtwo NiTi rotary file (n=18). Canals were instrumented according to the protocols recommended by manufacturers. Extents of apical transportation were measured on digital scanned and standardized images. Data were compared by ANOVA.

Results: The groups had a significant difference (P<0.001). Tukey test showed that the difference between the rotary instruments was insignificant, while the difference between each of them and K-file was significant (P <0.05).

Conclusion: Apical transportation caused by the stainless steel hand instruments is much greater than that of nickel titanium rotary instruments RaCe and Mtwo. Both rotary systems act alike.

Keywords: Endodontics, Apical transportation, Stainless steel files, Nickel titanium files, Rotary systems.

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Introduction

A critical phase of endodontic therapy is mechanical manipulation of root canal to remove its microbial and other debris by enlarging the canal plus its chemical irrigation without disrupting the root anatomy [1-3]. Different approaches are proposed to reduce the risk of damage to the canal during the manipulation of the canal system [1]. However, risk of canal damage caused during the canal treatment still exists, particularly in the case of flattened and curved canals [1,4]. One of the difficulties is when the instrument cannot follow the original path of the canal, but tends to prepare the canal in a straighter path because of its original straight shape and lack of flexibility necessary to bend through the canal's center [3,5,6]. This is called transportation and happens particularly in curved canals or while using rather rigid instruments [3,5,6]. When more extents of dentin are removed from the outer walls of the apical areas and inner walls of the coronal parts, transportation happens. In this case, one side of the canal will be removed in a single direction more than other directions, leading to a iatrogenic displacement of the end of the canal [1,7]. Because of the limited access to the new apical foramen and an inadequate debridement and cleansing, apical transportation intensifies amassing of microbial and residual debris [1]. Besides, a deformed canal shape disallows efficient condensation of gutta-percha during the final treatment phase (obturation). The resulted obturations materials overextended from the canal end as well as the inadequate condensation of them again increase the failure risk [1,8]. Therefore, it is crucial to follow the original path of the canal [3,9].

It is possible even in canals that are severely curved to maintain the original shape of the root canal and minimize the transportation risk [3,10]. Various preparation methods and tools are suggested to solve this issue [3,11]. According to their manufacturers, rotary Nickel-Titanium (NiTi) files have enhanced potential for canal shaping and thus might be the tool of choice for the preparation of highly curved canals [3]. Even manufacturers have claimed that with rotary NiTi files, fewer files are needed to prepare the apical area adequately [3,12]. Most rotary NiTi instruments are used according to the crown-down technique which means that larger instruments first widen the coronal parts of the canal, and the size of the instrument becomes smaller each time the file is supposed to be inserted deeper. There is an exception to that: The Mtwo system is used by the "single length technique"; in this technique, the first instrument is inserted full length up to the apex [1,13]. This mechanism might assist keeping the canal's original path while removing debris better than other NiTi instruments [1]. Mtwo files possess two cutting edges with sharp posterior aspects which might improve the cutting efficacy, facilitate the movement of the file within the canal, and increase control over it within the canal [13]. RaCe rotary files are triangular in cross section and have alternating cutting edges, in order to reduce the working torque and prevent the file blockage usually caused as a function constant instrument rotation within the canal. RaCe files are used according the crown-down protocol and hence have non-cutting tips [13].

Due to the importance of this topic and the controversial results obtained before, we investigated the apical transportation of Mtwo rotary files in comparison with a conventional K-File stainless steel (SS) hand-instrument and another rotary file (RaCe).

Materials and Methods

This *in vitro* experimental study was performed on 51 simulated canals with standardized shapes, all having a 40° angle of curvature. These canals were made within blocks of transparent polyester resin of high hardness. The Knoop hardness of the resin blocks was standardized as 40 kg/mm^2 [14]. The groups consisted of K-File SS hand-instrument (Maillefer, Ballaigues, Switzerland) (n=15), RaCe NiTi rotary file (FKG Dentaire, La Chaux-de-Fonds, Switzerland) (n=18), and Mtwo NiTi rotary file (VDW GmbH, Munich, Germany) (n=18). Before the instrumentation begins, the initial file was placed within the canal (full working length). The block was placed over a scanner device, from the side which showed the maximum curve of the canal, using a frame designed and made to hold all the blocks in a standardized position. The scanner scanned the transparent blocks at 600 DPI resolution [14]. The images were saved as pre-instrumentation images.

A dentist experienced in endodontics carried out the hand instrumentations. In the control group, it was performed using SS K-files with step-back file motion on all specimens. The initial file size was #15, and the master apical file was #35. The instrument was not pre-curved. The canal was irrigated with about 5 mL of NaOCl diluted to 2.5% concentration, between each two file numbers. The irrigation was performed using a gauge 27 syringe. In the rotary groups, it was carried out exactly according to the instructions made by the manufacturers, and at standardized torques and speeds [14]. When the instrumentation finished, it was irrigated. Then the master apical file (in the control group) or the final file (in the rotary groups) was re-inserted full-length in the canal and kept that way. Digital images of 600 DPI resolutions were again obtained from the resin blocks placed in standardized positions (using the frame mentioned above) over the scanner surface [14].

In the computer, the pre-treatment and post-treatment images pertaining to each transparent block were superimposed using Photoshop (Adobe, USA). The digital zoom of the software was used to magnify the two-layer (superimposed) image to 10x. The "distance measure" tool of Photoshop was used to measure the distance between the tips of the final and initial instruments (in mm), as the extent of canal transportation [14]. Descriptive statistics were calculated. A Kolmogorov-Smirnov test showed sample normality. Extents of apical transportation were compared using the analysis of variance (ANOVA) as well as the Tukey post hoc test. Level of significance was predetermined as 0.05.

Results

One of the Mtwo specimens was failed. The transportation was much smaller in the groups prepared with rotary instruments, compared to the group prepared with the hand instrument (Table 1). The ANOVA indicated a significant difference between the groups (P<0.001). The Tukey test showed that the difference between the rotary instruments was insignificant, while the difference between each of them and K-file was significant (Table 2).

Table 1. *Descriptive statistics for apical transportation (mm) of simulated canals in three groups treated with rotary and conventional systems.*

File	Mean	SD	Minimum	Maximum	95% CI	
Mtwo	0.21	0.02	0.18	0.24	0.2	0.2
RaCe	0.19	0.02	0.16	0.22	0.2	0.2
K-File	1.83	0.19	1.6	2.2	1.7	1.9

SD: Standard Deviation; CI: Confidence Interval

Table 2. *Results of Tukey post hoc test, comparing each system with the other two systems.*

Groups	Mean Difference (mm)	P	95% CI for difference
K-File vs Mtwo	1.618	P<0.05	1.528 to 1.708
K-File vs RaCe	1.639	P<0.05	1.550 to 1.728
Mtwo vs RaCe	0.021	P>0.05	-0.065 to 0.107

CI: Confidence Interval

Discussion

According to our findings, the apical transportation of the rotary instruments examined is smaller than that of conventional hand instruments; whereas, both rotary systems might act similarly in terms of causing apical transportation. Our results were in line with some previous studies in this regard in terms of the efficiency of RaCe. RaCe instruments have proved successful in bending properly in the canal during the rotation and following the original shape of the canal well, and thus causing minimum or no transportation in curved canals even in S-shaped canals [3,13,12]. Nevertheless, some studies have reported greater extents of canal transportation using RaCe instruments compared with Hero Shaper, ProTaper, ProFile, and K3 instruments [2,3]. Some of the less favorable results pertaining to RaCe might be owing to the usage of RaCe rotary SS instruments at speeds lower than recommended rotational speeds [3,12]. Also our findings showed a poorer result of K-files (greater transportation) compared to the rotary NiTi files, which this accorded with earlier research exhibiting that NiTi files could produce smaller apical transportations [15].

This research was limited by some constraints. A larger sample would benefit the reliability of results. Studies evaluating the effects of filing on canal geometry should be standardized in terms of canal shape and size, Knoop hardness, the position of blocks while imaging, and an apical diameter equal or close to the size of the #35 file [14,16]. There is not an agreed-upon gold standard to estimate the apical transportation [3]. Different techniques with various limitations are suggested in this matter [3,17]. These include radiographic imaging [3,18], computed tomography [3], cross-sectioning [3,19], and longitudinal sectioning of the root specimens [3]. Also extracted teeth cannot be standardized because they highly differ in size and shape from case to case [14,16]. The method used in this study benefited from direct visual clearance, which could improve the accuracy and reliability. Moreover, resin blocks might be made to any custom shape, size, or curvature [14,16], and thus can standardize the methods by excluding parameters that might influence the preparation outcome [14,20,21]. However, resin blocks might have a low hardness [14,20,22] which might be about half the hardness of teeth [14,23]. They are nevertheless declared as valid alternatives for teeth after various tests have been conducted on them [14-16,21]. Small hardness differences between the resin used to simulate the dentin and the natural dentin might confound the outcome [14,20,22]. We used high hardness resin blocks to ensure the highest comparability with natural teeth since their hardness is similar to that of teeth with similar transportation extents [14,21]. Still, use of natural teeth would improve the generalizability. Moreover, it would be better to have more than one operators and examiners.

Conclusion

The apical transportation caused by the SS hand instruments is much greater than that of nickel titanium rotary instruments RaCe and Mtwo. Hence, clinical use of rotary systems is recommended.

References

1. Madani ZS, Haddadi A, Haghanifar S, Bijani A. Cone-beam computed tomography for evaluation of apical transportation in root canals prepared by two rotary systems. Iran Endod J 2014; 9: 109-112.
2. Alsudani D, Alshahrani S. A Comparison of the Canal Centering Ability of ProFile, K3, and RaCe Nickel Titanium Rotary Systems. J Endod 2006; 32: 1198-1201.
3. Honardar K, Assadian H, Shahab S, Jafari Z, Kazemi A, Nazarimoghaddam K. Cone-beam Computed Tomographic Assessment of Canal Centering Ability and Transportation after Preparation with Twisted File and Bio RaCe Instrumentation. J Dent (Tehran) 2014; 11: 440-446.
4. Bergmans L, Van Cleynenbreugel J, Beullens M, Wevers M, Van Meerbeek B, Lambrechts P. Smooth flexible versus active tapered shaft design using NiTi rotary instruments. Int Endod J 2002; 35: 820-828.
5. Fogarty TJ, Montgomery S. Effect of preflaring on canal transportation. Oral Surg Oral Med Oral Pathol 1991; 72: 345-350.
6. Câmara AC, Aguiar CM, de Figueiredo JAP. Assessment of the Deviation after Biomechanical Preparation of the Coronal, Middle, and Apical Thirds of Root Canals Instrumented with Three HERO Rotary Systems. J Endod 2007; 33: 1460-1463.
7. Hartmann MSM, Barletta FB, Camargo Fontanella VR, Vanni JR. Canal Transportation after Root Canal Instrumentation: A Comparative Study with Computed Tomography. J Endod 2007; 33: 962-965.
8. Tasdemir T, Aydemir H, Inan U, Unal O. Canal preparation with Hero 642 rotary Ni-Ti instruments compared with stainless steel hand K-file assessed using computed tomography. Int Endod J 2005; 38: 402-408.
9. SchÄFer E, Dammaschke T. Development and sequelae of canal transportation. Endodontic Topics 2006; 15: 75-90.
10. Gergi R, Rjeily JA, Sader J, Naaman A. Comparison of Canal Transportation and Centering Ability of Twisted Files, Pathfile-ProTaper System, and Stainless Steel Hand K-Files by Using Computed Tomography. J Endod 2010; 36: 904-907.
11. Tsesis I, Amdor B, Tamse A, Kfir A. The effect of maintaining apical patency on canal transportation. Int Endod J 2008; 41: 431-435.
12. Bonaccorso A, Cantatore G, Condorelli GG, Schäfer E, Tripi TR. Shaping Ability of Four Nickel-Titanium Rotary Instruments in Simulated S-Shaped Canals. J Endod 2009; 35: 883-886.
13. Ehsani M, Zahedpasha S, Moghadamnia AA, Mirjani J. An ex-vivo study on the shaping parameters of two nickel-titanium rotary systems compared with hand instruments. Iran Endod J 2011; 6: 74-79.
14. Khalilak Z, Fallahdoost A, Dadresanfar B, Rezvani G. Comparison of extracted teeth and simulated resin blocks on apical canal transportation. Iran Endod J 2008; 3: 109-112.
15. Tharuni S, Parameswaran A, Sukumaran V. A comparison of canal preparation using the K-file and lightspeed in resin blocks. J Endod 1996; 22: 474-476.
16. Weine FS, Kelly RF, Lio PJ. The effect of preparation procedures on original canal shape and on apical foramen shape. J Endod 1975; 1: 255-262.
17. Duran-Sindreu F, García M, Olivieri JG, Mercadé M, Morelló S, Roig M. A Comparison of Apical Transportation between FlexMaster and Twisted Files Rotary Instruments. J Endod 2012; 38: 993-995.

18. Sydney GB, Batista A, de Melo LL. The radiographic platform: A new method to evaluate root canal preparation in vitro. J Endod 1991; 17: 570-572.
19. Kosa DA, Marshall G, Craig Baumgartner J. An analysis of canal centering using mechanical instrumentation techniques. J Endod 1999; 25: 441-445.
20. Calberson FLG, Deroose CAJG, Hommez GMG, Raes H, De Moor RJG. Shaping ability of GTTM Rotary Files in simulated resin root canals. Int Endod J 2002; 35: 607-614.
21. Ahmad M. The validity of using simulated root canals as models for ultrasonic instrumentation. J Endod 1989; 15: 544-547.
22. Yang GB, Zhou XD, Zhang H, Wu HK. Shaping ability of progressive versus constant taper instruments in simulated root canals. Int Endod J 2006; 39: 791-799.
23. Weine F. Endodontic therapy 6th ed. St.Louis, Missouri: Mosby; 2004.

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