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Evaluation of Canal Transportation And Straightening Of The Mesiobuccal Canal Of Mandibular First Molars Prepared by ProTaper Next, OneShape and F6 SkyTaper Using CBCT- A Comparative Invitro Study

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Abstract **Original Research Article**

The aim of this study was to compare and evaluate the canal transportation and straightening of the mesiobuccal canal of mandibular first molars prepared by ProTaper Next, OneShape and F6 SkyTaper using cone-beam computed tomography (CBCT). Sixty six mesiobuccal root canals of extracted mandibular first molars with curvatures 20- 40˚ and length 19-22mm were used. Teeth embedded in acrylic resin block were assigned to three groups and prepared using ProTaper Next, OneShape and F6 SkyTaper files. CBCT images were obtained before and after instrumentation to compare the canal transportation at 2mm, 5mm and 8mm from the root apex and also to assess the canal curvatures for straightening. The obtained results were analysed using Kruskal Wallis test to compare the mean canal transportation. One-way ANOVA test followed by Tukey's Post hoc analysis was used to compare the mean canal straightening between the groups. ***Results:*** The least canal transportation occurred with F6 SkyTaper group, followed by OneShape group and ProTaper Next group at all the levels which was statistically significant. Mean values for canal straightening among the groups were not significantly different. ***Conclusion*:** Although all the three rotary systems caused some degree of canal transportation and straightening, the single Ni-Ti rotary file F6 SkyTaper system caused significantly least canal transportation and straightening than the other file systems.

Keywords: Canal transportation, Canal straigtening, ProTaper Next, OneShape, F6 SkyTaper, Cone-beam computed tomography.

INTRODUCTION

Endodontic therapy is defined as "the total tissue debridement followed by fluid tight obturation of the prepared root canal space, as stated by Grossman" [1]. Canal preparation is adversely influenced by the highly variable root canal anatomy and relative inability of the operator to visualize this anatomy on radiographs [2]. Canal transportation and straightening leads to weakening of entire root; insufficient cleaning of root canals, where untouched recesses harbours the residual bacterial biofilms. This serves as a potential cause for persistent infection leading to poor treatment outcome [3].

In 1988, Walia *et al*., reported that, Ni-Ti files demonstrated greater elastic flexibility, resistance to torsional fracture, superior shape memory and low modulus of elasticity which are advantageous over hand instruments [4]. The use of rotary (Ni-Ti) instrumentation has recently increased because of easier and safer root canal shaping with predictable results with less iatrogenic damage even in severely curved root canals [5].

ProTaper Next (Dentsply Maillefer, Switzerland) is a NiTi multifile rotary system manufactured from M-wire Ni-Ti alloy. It has a off-centered rectangular cross section giving a unique asymmetric rotary motion [6]. OneShape (Micro Mega, France) is a single file NiTi rotary system with constant taper. It has an asymmetric cross-sectional design consisting of three symmetrical cutting edges at its tip; in the middle the number decreases to two asymmetrical cutting edges that progressively changes to an S-shaped cross section near the shaft. It is used in continuous rotational motion and has a variable pitch which reduces the instrument screwing effect [7-9].

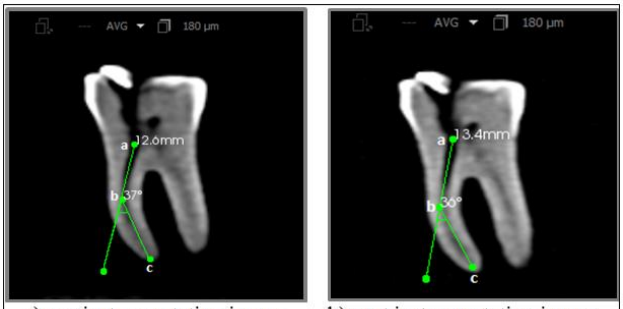
Recently, a new single file system, F6 SkyTaper was introduced for quick and safe root canal preparation. It is used in a continuous clockwise rotational motion, characterized by a modified S-shaped cross sectional design and has 2 sharp cutting edges which exhibited highest cyclic fatigue resistance and increased flexibility [10].

Recently, a non-invasive 3D imaging technologies have been developed. Among which, Cone Beam Computed Tomography (CBCT) is advocated as a promising tool for studying the root canal anatomy. It utilizes a cone-shaped X-ray beam and an area detector that captures a cylindrical volume of data in one acquisition. Advantages of CBCT are, it can render cross-sectional and 3D images that are highly accurate, high resolution, fully quantifiable and provides repeatable results [11].

Thus, the aim of the present study was to compare and evaluate the canal transportation and straightening of the mesiobuccal canal of mandibular first molars prepared by ProTaper Next, OneShape and F6 SkyTaper using cone-beam computed tomography.

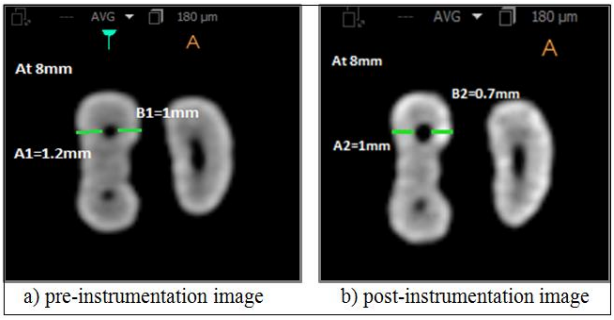
METHODOLOGY

Sixty six human mandibular molars were used and access cavities were prepared by using the size No.2 Endo access bur (Mani, Japan). The mesiobuccal canal was explored with a #10-K type file (Mani, Japan) until the file tip was visible from the root apex. Later, 1mm was subtracted from the obtained length which was considered as the working length in the range of 19-22mm. Metal moulds of inner dimensions 1.5cm×1.5cm×2cm were filled with acrylic resin where teeth were embedded to the level of cemento-enamel junction. These blocks were removed, coded and positioned on a customized silicone template fitted to a chin support of CBCT unit to obtain accurate and reproducible CBCT images. Three dimensional, high resolution images were obtained from CBCT (CS 9300 Carestream) with a 6cm field of view (FOV) using 60 kilovoltage, 2.5mA and 8.01s of exposure time. The images were transferred to CS 3D imaging software 3.2.9 (Carestream Health, Inc, USA) where the images along the sagittal plane (mesiodistally) were obtained to calculate the angle of canal curvature using Schneider's method (angle of curvature in the range between 20-40˚ was selected, (in Fig-1): Point 'a': at the level of canal orifice, a straight line was drawn from point 'a' parallel to the long axis of the canal. Point 'b': was marked where the canal flare starts to deviate. Point 'c': was marked at apical foramen. A line was drawn from point 'c' to 'b' and the angle formed by the intersection of these lines was measured. The results other than "zero", indicates canal straightening.



a) pre-instrumentation image b) post instrumentation image

Fig-1: Evaluation of canal straightening before and after instrumentation



a) pre-instrumentation image b) post-instrumentation image

Fig-2: Evaluation of canal transportation before and after instrumentation at 8mm.

Then, three pre-instrumentation images along the cross sectional plane (axial slice thickness of 0.5mm) were taken at a distance of 2mm, 5mm and 8mm from the radiographic apex, to analyse for canal transportation. A # 10K file was used with 17% EDTA (Endoprep-RC) to negotiate mesiobuccal canals and to provide a glide path. The canals were irrigated with 2ml of 3% NaOCl (VIP, Vensons). Then, all the teeth were randomly divided into 3 groups of 22 teeth each (n= 22). All the files were instrumented in a continuous clockwise rotational motion according to the manufacturer using X-Smart Plus endomotor (Dentsply-

Maillefer, Switzerland) and each canal was irrigated with 2ml of 3% NaOCl and dried with paper points.

GROUP I (n=22): The mesiobuccal canal was prepared using multifile ProTaper **Next** system to a final size of X2 (25 size/0.06 taper) at a speed of 300rpm and 2.0Ncm torque with outward brushing motion.

GROUP II (n=22): The mesiobuccal canal were prepared using OneShape single file system to a size of 25/0.06 taper at a speed of 350rpm and 2.5Ncm torque with in and out motion without pressure.

GROUP III (n=22): The mesiobuccal canal was prepared using F6 SkyTaper single file system to a size of 25/0.06 taper at a speed of 300rpm and 2.2Ncm torque in pecking motion (up and down).

Later, both the pre- and post-instrumentation images were compared for evaluating canal transportation and straightening. Canal transportation was evaluated by Gambill's technique (in Fig-2) using a formula — $(A_1 - A_2) - (B_1 - B_2)$ where, A_1 & A_2: The shortest distance from the external mesial surface of the root to the outermost point on the unprepared root canal and prepared root canal respectively. B_1 & B_2: The shortest distance from the external distal surface of the root to the outermost point on the unprepared and prepared root canal. According to this formula, result of "zero" shows no canal transportation, while any other result indicates the occurrence of transportation. The obtained data was statistically analysed using SPSS software in Windows version 22.0 (Armonk, NY: IBM Corp). Kruskal Wallis test followed by Mann Whitney Post hoc analysis was used to compare the mean canal transportation at 2mm, 5mm and 8 mm between the groups. One-way ANOVA test followed by Tukey's Post hoc analysis was used to compare the mean degree of angle of curvature between the groups before and after instrumentation.

RESULTS

In the present study, the instrumented mesiobuccal canals were transported towards outer (mesial direction) and inner (distal direction) curvature of the root canal at 2mm, 5mm and 8mm from the apex. The positive values represents the canals that were transported towards mesial direction, whereas negative values represents the canals that were transported towards distal direction. However, majority of the canals were transported towards mesial direction at all the levels.

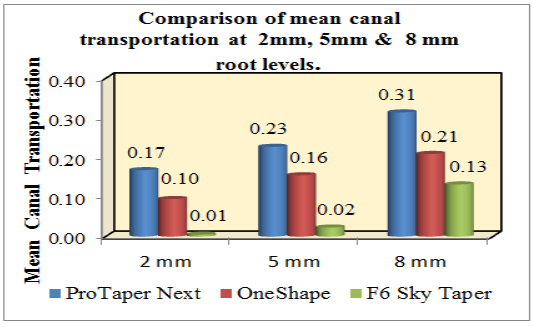
At all the levels, the least canal transportation was observed with F6 SkyTaper group, followed by OneShape group and greatest value was seen with ProTaper Next

Table-1: Comparison of mean canal transportation at 2mm, 5mm & 8mm cross sectional planes between 3 groups using Kruskal Wallis test

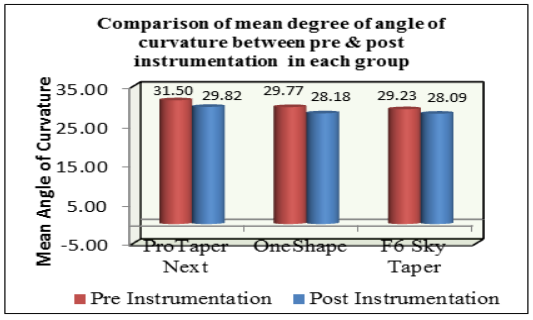
Canal levels	Groups	N	Mean	SD	Min	Max	H	P-Value
2mm	ProTaper Next	22	0.17	0.11	0.0	0.4	16.676	<0.001*
	OneShape	22	0.10	0.13	-0.1	0.4		
	F6 SkyTaper	22	0.01	0.11	-0.1	0.2		
5mm	ProTaper Next	22	0.23	0.15	-0.1	0.5	23.957	<0.001*
	OneShape	22	0.16	0.13	0.0	0.5		
	F6 SkyTaper	22	0.02	0.08	-0.1	0.1		
8mm	ProTaper Next	22	0.31	0.14	-0.1	0.5	24.231	<0.001*
	OneShape	22	0.21	0.10	0.0	0.4		
	F6 SkyTaper	22	0.13	0.09	-0.1	0.3		

* Statistically Significant

When canal straightening was compared, F6 SkyTaper showed least canal straightening with the mean value of 1.14˚ which was not statistically significant when compared to OneShape and ProTaper Next groups. Whereas OneShape group showed 1.59˚of canal straightening which was not statistically significant when compared to ProTaper Next group which showed highest value of 1.68˚ (Graph-2).



Graph-1:



Graph-2:

DISCUSSION

The cleaning and shaping phase holds an important role as it may influence the success of the following phase, which may affect the whole prognosis of the endodontic treatment. Adequate instrumentation combined with effective irrigation is required to achieve sufficient disinfection during root canal treatment [12]. Canal transportation leads to accumulation of the residual debris and micro-organisms due to the absence of proper and adequate debridement of the root canal, persisting apical lesions and thinned canal walls that could result in perforations or root fracture. Also the shape created due to the canal transportation does not provide a resistant form to condense gutta percha and results in its poor compaction and over-extension of obturating materials, which finally leads to failure of the treatment [13]. Canal straightening is the resultant of canal transportation where asymmetrical dentin removal leads to decrease in canal curvature as the long axis of the canal gets displaced [14, 15]. Mesiobuccal canal (MB) of mandibular first molars was selected because it usually has 20-45° of canal curvature in most of the cases, which makes it more suitable for assessment of transportation [16]. Cone beam computerized tomography is a non-invasive technology that produce highly accurate, high resolution, fully quantifiable and provides repeatable results. The technique reduces the incidence of false negative results as it overcomes the limitations of the conventional radiographs such as distortion, anatomic superimposition and compression of three-dimensional objects into two-dimensional images [17-20]. The finding of the present study was that the canal transportation values at the 2-mm level were in the range 0.10-0.17 mm. These values are less than the 'critical' canal transportation value of 0.3-mm defined by Wu *et al*., [21]

PTN showed less canal transportation at the apical third followed by middle and coronal third, this could be attributed to the progressive taper of file apically and decreasing taper coronally which makes the file more flexible at the apical section causing less canal transportation at the apical third of the canal [22]. In addition, PTN has a unique swaggering motion like a snake due to its off-centered rectangle cross section. PTN which has rectangle cross section, high screw-in force and decreasing coronal taper causes more canal transportation at middle and coronal end [23]. OneShape (OS) group showed greater canal transportation values at coronal third of the canal, followed by middle third and least at apical third of the canal which were statistically significant. This could be due to the progressive cutting edges that changes from tip (3 symmetric cutting edges) to the middle (2 asymmetric cutting edges) and to the shaft region (2 cutting edges with S-shaped cross section design) on the file. F6 SkyTaper (F6) group showed lesser canal transportation in the apical and middle third of the canal where no statistical significant difference was found. Whereas in the coronal third, greater canal transportation was noted that was statistically significant from the other levels. This could be attributed to the decreasing coronal taper causing more canal transportation than apical and middle third of the canal respectively. All the files straightened the apical curvature but no statistical significant difference was found between the groups. This is in agreement with the findings of previous studies [6, 24-28]. One reason for this finding is that all the instruments have noncutting tips that work with minimal apical pressure and function only as a guide to allow easy penetration [29].

Further, more research and studies are required for the evaluation of removed dentin volume, change of surface area and radius of curvature after using different instrumentation techniques to verify the clinical efficacy for shaping of the canal and enlighten the fraternity.

CONCLUSIONS

Within the limitations of this in vitro study it can be concluded that,

- F6 SkyTaper group showed the least canal transportation at 2mm, 5mm and 8mm when compared to OneShape and ProTaper Next group. ProTaper Next group showed greater canal transportation at all the root levels with statistical significant difference between them.
- All the groups showed least canal transportation at 2mm followed by 5mm and 8mm from the root apex.
- When canal straightening was compared between the groups, F6 SkyTaper group showed the least canal straightening when compared to OneShape and ProTaper Next group. However, there was no statistical significant difference between all the groups.

REFERENCE

1. Grossman LI. Root Canal Therapy. 3rd ed. Philadelphia: Lea & Febiger; 1950.
2. Peters OA. Current challenges and concepts in the preparation of root canal systems: a review. Journal of endodontics. 2004 Aug 1;30(8):559-567.
3. Thompson M, Sidow SJ, Lindsey K, Chuang A, McPherson III JC. Evaluation of a new filing system's ability to maintain canal morphology. Journal of endodontics. 2014 Jun 1;40(6):867-70.
4. Schäfer E, Dammaschke T. Development and sequelae of canal transportation. Endodontic topics. 2006 Nov;15(1):75-90.
5. Özer SY. Comparison of root canal transportation induced by three rotary systems with noncutting tips using computed tomography. Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology. 2011 Feb 1;111(2):244-50.
6. Capar ID, Ertas H, Ok E, Arslan H, Ertas ET. Comparative study of different novel nickel-titanium rotary systems for root canal preparation

in severely curved root canals. Journal of Endodontics. 2014 Jun 1;40(6):852-6.
7. Saleh AM, Gilani PV, Tavanafar S, Schäfer E. Shaping ability of 4 different single-file systems in simulated S-shaped canals. Journal of endodontics. 2015 Apr 1;41(4):548-52.
8. Ghobashy A, Nagy MM, Obeid MF. Shaping ability of single versus multi file rotary Ni-Ti systems in curved root canals. Tanta Dental Journal. 2016 Apr 1;13(2):68-72.
9. Kumar SR, Gade V. Single file Ni-Ti rotary systems. *IJMDS*, 2015;4:701-705.
10. Kaval ME, Capar ID, Ertas H, Sen BH. Comparative evaluation of cyclic fatigue resistance of four different nickel-titanium rotary files with different cross-sectional designs and alloy properties. Clinical oral investigations. 2017 Jun 1;21(5):1527-30.
11. Jain A, Asrani H, Singhal AC, Bhatia TK, Sharma V, Jaiswal P. Comparative evaluation of canal transportation, centering ability, and remaining dentin thickness between WaveOne and ProTaper rotary by using cone beam computed tomography: An in vitro study. Journal of conservative dentistry: JCD. 2016 Sep;19(5):440-444.
12. Elsherief, S. M., Zayet, M. K., & Hamouda, I. M. (2013). Cone-beam computed tomography analysis of curved root canals after mechanical preparation with three nickel-titanium rotary instruments. *Journal of biomedical research*, *27*(4), 326-335.
13. 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. Iranian endodontic journal. 2014;9(2):109-112.
14. Weine FS, Kelly RF, Lio PJ. The effect of preparation procedures on original canal shape and on apical foramen shape. Journal of endodontics. 1975 Aug 1;1(8):255-62.
15. Chole D, Burad PA, Kundoor S, Bakle DS, Devagirkar A, Deshpande DR. Canal transportation-a threat in endodontics: a review. IOSR-JDMS. 2016;15:64-72.
16. Asghari F, Samiei M, Adibkia K, Akbarzadeh A, Davaran S. Biodegradable and biocompatible polymers for tissue engineering application: a review. Artificial cells, nanomedicine, and biotechnology. 2017 Feb 17;45(2):185-92.
17. Balani P, Niazi F, Rashid H. A brief review of the methods used to determine the curvature of root canals. Journal of Restorative Dentistry. 2015 Sep 1;3(3):57-63.
18. Elsherief SM, Zayet MK, Hamouda IM. Cone-beam computed tomography analysis of curved root canals after mechanical preparation with three nickel-titanium rotary instruments. Journal of biomedical research. 2013 Jul;27(4):326-335.
19. AgARwAl RS, AgARwAl J, JAin P, ChAnDRA A. Comparative analysis of canal centering ability of different single file systems using cone beam computed tomography-An in-vitro study. Journal of Clinical and Diagnostic Research: JCDR. 2015 May;9(5):ZC06-ZC10.
20. Mamede-Neto I, Borges AH, Guedes OA, de Oliveira D, Pedro FL, Estrela C. Root canal transportation and centering ability of nickel-titanium rotary instruments in mandibular premolars assessed using cone-beam computed tomography. The open dentistry journal. 2017;11:71-78.
21. Wu T, Yoo CS. Keeping the internet neutral?: Tim Wu and Christopher Yoo debate, 2007.
22. Shenoi PR, Luniya DA, Badole GP, Makade CS, Kubde R, Khode RT. Comparative evaluation of shaping ability of V-Taper 2H, ProTaper Next, and HyFlex CM in curved canals using cone-beam computed tomography: An in vitro study. Indian Journal of Dental Research. 2017 Mar 1;28(2):181-186.
23. Shivashankar MB, Niranjan NT, Jayasheel A, Kenchanagoudra MG. Computed tomography evaluation of canal transportation and volumetric changes in root canal dentin of curved canals using Mtwo, ProTaper and ProTaper Next rotary system-an in-vitro study. Journal of clinical and diagnostic research: JCDR. 2016 Nov;10(11):ZC10.
24. Celik V, Yesilyurt E. Attitudes to technology, perceived computer self-efficacy and computer anxiety as predictors of computer supported education. Computers & Education. 2013 Jan 1;60(1):148-58.
25. Marzouk AM, Ghoneim AG. Computed tomographic evaluation of canal shape instrumented by different kinematics rotary nickel-titanium systems. Journal of endodontics. 2013 Jul 1;39(7):906-9.
26. You SY, Kim HC, Bae KS, Baek SH, Kum KY, Lee W. Shaping ability of reciprocating motion in curved root canals: a comparative study with micro–computed tomography. Journal of endodontics. 2011 Sep 1;37(9):1296-300.
27. Bürklein S, Benten S, Schäfer E. Shaping ability of different single-file systems in severely curved root canals of extracted teeth. International endodontic journal. 2013 Jun;46(6):590-7.
28. Bürklein S, Jäger PG, Schäfer E. Apical transportation and canal straightening with different continuously tapered rotary file systems in severely curved root canals: F6 SkyTaper and OneShape versus Mtwo. International endodontic journal. 2017 Oct;50(10):983-90.
29. Kum KY, Spängberg L, Cha BY, Il-Young J, Seung-Jong L, Chan-Young L. Shaping ability of three ProFile rotary instrumentation techniques in simulated resin root canals. Journal of endodontics. 2000 Dec 1;26(12):719-23.