DOI: 10.7860/JCDR/2014/8702.5101

Dentistry Section

Original Article

Modifications in Canal Anatomy of Curved Canals of Mandibular First Molars by two Glide Path Instruments using CBCT

ANIL DHINGRA[1], NAYASHA MANCHANDA[2]

ABSTRACT

Background: The creation of glide path reduces the risk of instrument breakage. Glide path is created before using NiTi rotary instrumentation

Aim: This study compared the changes in the root canal anatomy after creation of glide path using Path Files (PF) and V Glide Path 2 (VGP2) using Cone Beam Computed Tomography (CBCT).

Materials and Methods: Hundred extracted mandibular first molars with curved mesial roots, curvature angles ranging within 20-30 degrees were assigned into two groups (n = 50 each). Glide path was prepared using PF (Group I) and VGP2 (Group II). CBCT images were obtained before and after instrumentation. The technical outcomes were compared at 0, 1, 2, 3, 5 and 7mm intervals. The data was analyzed using t-test and Chi-square test.

Result: There was a statistical difference between the root canal curvatures and working time between the two groups ($p < 0.05$). Canals transported towards the distal side in Group II but there was a slight mesial transportation in Group I at 0mm. Group I exhibited a better centric ability except at 1mm interval ($p > 0.05$). The changes in the volume were statistically significant only at 2mm interval ($p < 0.05$). The difference in the cross sectional area was not statistically significant at any interval ($p > 0.05$).

Conclusion: Within the limits of this study the rotary Nickel Titanium Path Files appeared to be suitable instruments for safe and easy creation of glide path.

Keywords: Nickel Titanium, Root canal, root canal preparation

INTRODUCTION

Successful root canal treatment is dependent upon the effective debridement and shaping of the root canal system [1,2]. The introduction of nickel–titanium (NiTi) alloys has revolutionized root canal preparation [3-6]. But, when these instruments are rotated in root canals, they are subjected to structural fatigue that eventually leads to failure [7,8].

Therefore Glide path creation is essential for the prevention of rotary file separation and most effective rotary use [9]. The endodontic Glidepath is a smooth radicular tunnel from canal orifice to physiologic terminus (foraminal constriction). Its minimal size should be that of a “super loose No. 10” endodontic file. The Glidepath is necessary for quality control and sustainable excellent endodontic obturations are not possible without it [10].

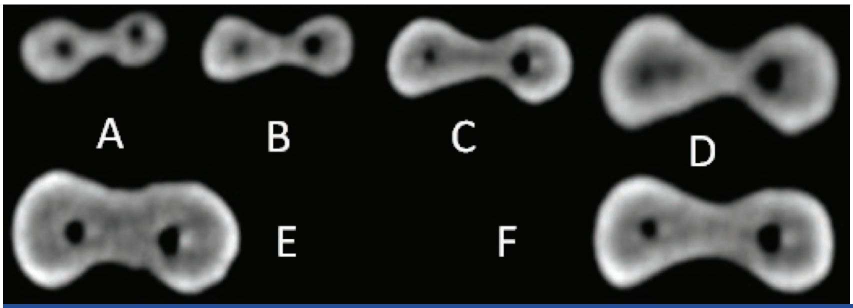
The lack of glide path establishment and glide path enlargement often causes ledge formation, transportation and blockage of root canals followed by the Obturation which is short of the apical constricture [11]. Thus, in order to be safe, before rotary shaping, the dentist must always discover if glide path already exists or needs to be created [12].

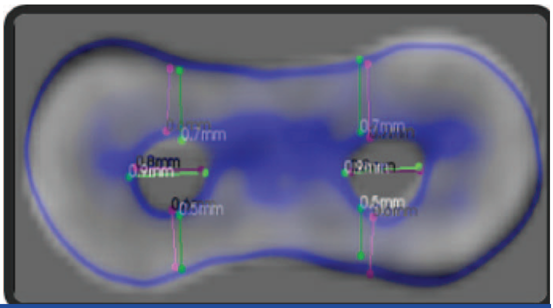
Cone Beam Computed Tomography (CBCT) provides a significantly faster image acquisition and reconstruction scheme and aids in the diagnosis of canal morphology [13,14]. As compared with conventional periapical radiography, CBCT eliminate superimposition of surrounding structures, providing additional clinically relevant information [15]. Even though resolution is not as high as that of conventional radiographs, the availability of 3-Dimensional information, a relatively higher resolution and a significantly lower dose than medical-grade Computed Tomography makes CBCT the imaging modality of choice in challenging situations demanding localization and characterization of root canals [14].

The aim of this study is to compare the changes in the root canal anatomy after creation of glide two different NiTi rotary instruments.

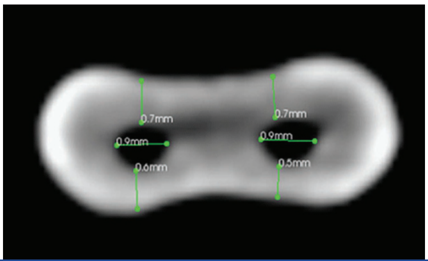
MATERIALS AND METHODS

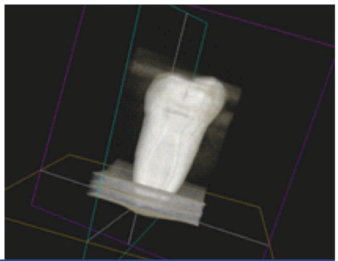
Selection and Specimen preparation: Hundred periodontally involved and caries free mandibular first molars were collected from a pool of extracted teeth stored in 10% formalin. Only the teeth with intact and mature root apices were included in the study. Inclusion criteria stipulated that the tooth had a curved mesial root with two separate canals and apices, with curvature angles ranging within 20-40° (Schneider 1971). Standardized radiographs were taken in a buccolingual and mesiodistal dimension before the instrumentation. The specimens were placed in a radiographic mount made of a silicone-based impression material (Aquasil Ultra; Dentsply International, New York, NY) so that a constant position could be obtained. This mount was positioned on a radiographic-paralleling device. The radiographs in the buccal-lingual dimension were taken to confirm the presence of two distinct and separate root canals. In the mesiodistal dimension, K file no. 10 was inserted into the buccal and lingual canal to assess the degree of root canal curvatures according to Schneider’s technique. Coronal access was achieved by using Endo-Access and Endo-Z burs (Dentsply Maillefer, Ballaigues, Switzerland) to obtain a straight line access. Each tooth was sectioned through the furcation and the mesial portion of the root and crown was used. Distal roots with the respective part of the crown were sectioned at the furcation level and discarded. All mesial root canals were controlled for apical patency with a K-File no. 10 (Dentsply Maillefer, Ballaigues, Switzerland). Working length was set 1 mm from the apical foramen which was taken using K-File no. 10 (Dentsply Maillefer, Ballaigues, Switzerland). Periapical radiographs were recorded to confirm the working length. Hundred teeth were randomly assigned to two different groups of 50 each. Teeth with



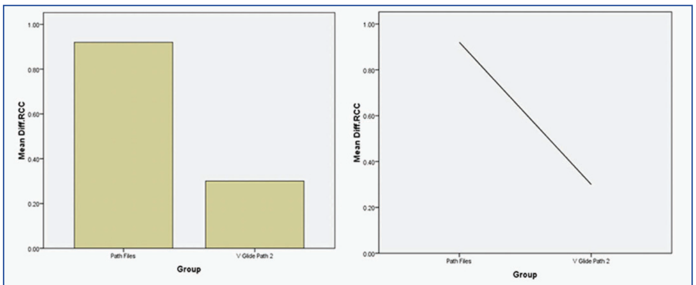


[Table/Fig-1]: CBCT image showing post instrumented axial sections at (A) 0mm (B) 1mm (C) 2mm (D) 3mm (E) 5mm and (F) 7mm **[Table/Fig-2]:** Superimposition of pre-operative and post-operative images (axial section)





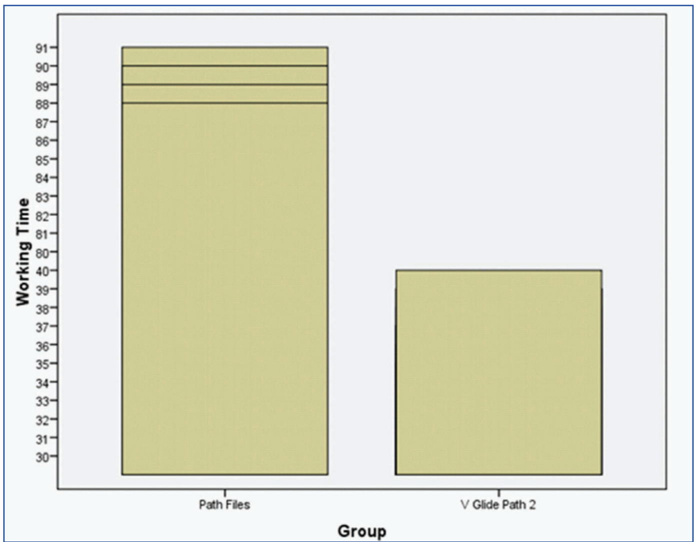
[Table/Fig-3]: CBCT image depicting root canal curvature in pre and post instrumented coronal section (A & B) and tansverse section (C & D) **[Table/Fig-4]:** CBCT image depicting the radius in axial section (post-instrumented) **[Table/Fig-5]:** Image depicting the volume of the root canals



[Table/Fig-6]: (A) Bar graph (B) Line graph: showing the comparison between the two groups indicating that root canal curvature was statistically significant between the instruments

Group	N	Mean± Std. Deviation	Std. Error	p value
Path Files	50	0.9200 ±0.42988	0.06079	≤0.000
V Glide Path 2	50	0.3000 ±0.93131	0.13171	

[Table/Fig-7]: Changes in the root canal curvature (degrees)



[Table/Fig-8]: Bar graph showing the comparison between the two groups indicating that the working time was statistically significant between the instruments

moderately and severe degrees of curvatures were allotted in similar numbers to each group.

Preinstrumented Specimen Scanning: Roots were embedded into transparent acrylic (Orthoplast, Zeist, Netherlands) and then the teeth were scanned by Cone Beam Computed Tomography (CBCT). The sections were 0.9 μm thick from apical to the canal orifice. All cross-section images (uninstrumented and instrumented) were studied at distances 0, 1, 2, 3, 5 and 7 mm from the most apical point of each specimen.

Root canal instrumentation: Both the groups were instrumented by the same operator. A new sequence of files was used for each canal. The teeth were divided into two instrumentation groups:

Group I, canals prepared with the PF (Dentsply Maillefer) (n = 50);

Group II, canals prepared with the VGP2 (S.S. White) (n = 50).

Coronal flaring was done in all the mesial canals using Protaper SX file (Dentsply Maillefer, Ballaigues, Switzerland) at 350 rpm in a brushing motion using the manufacturer's guidelines. All the canals were prepared using torque control motor (X-Smart, Dentsply Maillefer, Ballaigues, Switzerland) with a 16 : 1 reduction ratio contra-angle handpiece.

The canals in group I were prepared in the sequence PF 1 (0.13 mm), PF 2 (0.16 mm), PF 3 (0.19 mm) in continuous rotation to the working length. All PathFiles were utilized with a rotation speed of 300 rpm, a motor torque of approximately 5 N/cm and with delicate in/out movements until they reach the full length. Copious irrigation with 2 mL of distilled water was performed after the use of each rotary file by a 27-G irrigation needle.

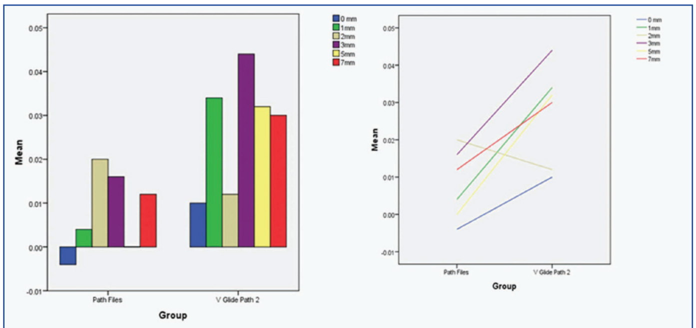
The canals in group II were prepared in the sequence VGP2 13 (03) and VGP2 17 (04) in continuous rotation to the working length in the same manner. Copious irrigation with 2 mL of distilled water was performed after the use of each rotary file by a 27-G irrigation needle.

CBCT scanning and measurements [16]

After the roots were embedded into transparent acrylic (Orthoplast, Zeist, Netherlands), the teeth were scanned pre and postoperatively in the high resolution dental mode (i.e. 90 micron resolution). The setting for the CBCT scanner was 84 kVp and 5 mA. All the scans were reoriented with respect to the x-, y- and z-axes, using the imaging software CS9300 equipment (Carestream Healthcare India (P) Ltd). Study images were reconstructed from the volumetric dataset, in planes perpendicular to the selected tooth axes. The transportation, centric ability, surface area and volume of the root canals were evaluated at 0.0, 1.0, 2.0, 3.0, 5.0 and 7.0 mm intervals

Group	N	Mean± Std. Deviation	Std. Error	P value
Path Files	50	85.06 ± 3.119	0.441	0.000
V Glide Path 2	50	34.44 ± 2.659	0.376	

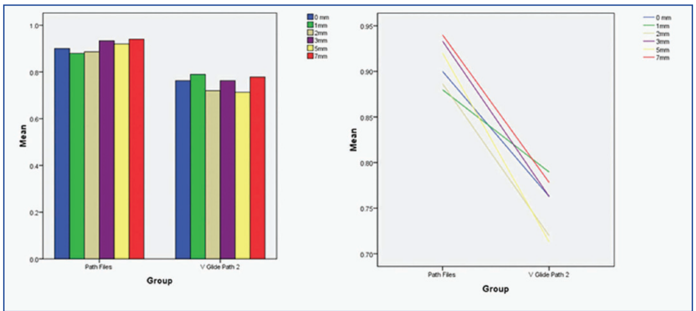
[Table/Fig-9]: Working time (minutes)



[Table/Fig-10]: (A) Bar graph (B) Line graph: showing the comparison between the two groups indicating canal transportation was statistically significant at all the intervals except at 1mm between the instruments

Interval (mm)	0	1	2	3	5	7
p Value	0.017	0.030	0.001	0.005	0.001	0.007

[Table/Fig-11]: Changes in the Canal transportation



[Table/Fig-12]: (A) Bar graph (B) Line graph: showing the comparison between the two groups indicating centric ability was not statistically significant at all the intervals between the instruments

[Table/Fig-1]. The pre and post instrumentation images were superimposed using G.I.M.P 2.8.4 software [Table/Fig-2].

Measurement of root canal curvature

The curvature of the mesiolingual and mesiobuccal canals was measured according to Schneider 1971 in both the coronal as well as transverse axis [Table/Fig-3a-d].

Measurement of working time

The time for canal preparation was recorded and included total active instrumentation (including the coronal flaring), instrument changes within the sequence, cleaning of the flutes of the instruments and irrigation.

Measurement of cross sectional area

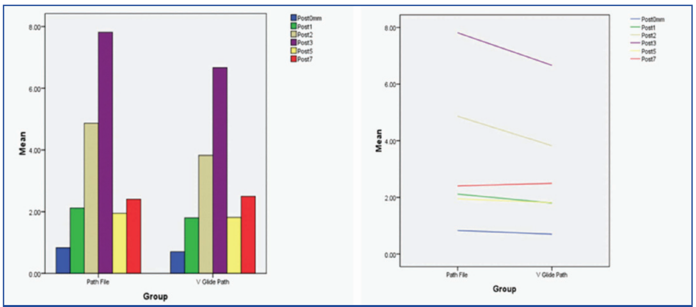
The radius of the pre and postoperative images was calculated in the axial sections at the various intervals. The area was calculated using the formula ϖr^2 [Table/Fig-4].

Measurement of volume

Using the MicroView 3-D volume viewer and analysis software, images of the canals before and after instrumentation were inverted rather than superimposition to assess the volume. The volume at each interval of each canal could be calculated before and after instrumentation. The mean changes in these parameters were determined for each group by subtracting the scores for the instrumented canals from those recorded for the uninstrumented canals [Table/Fig-5].

Interval(mm)	0	1	2	3	5	7
p Value	0.006	0.212	0.000	0.003	0.000	0.004

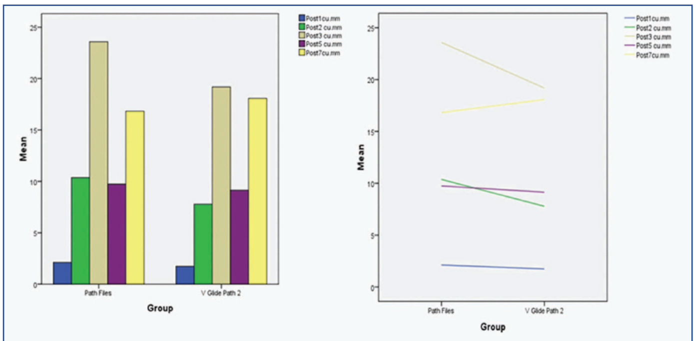
[Table/Fig-13]: Changes in the Centric ability



[Table/Fig-14]: (A) Bar graph (B) Line graph: showing the comparison between the two groups indicating cross-sectional was not statistically significant at all the intervals between the instruments

Interval (mm)	0	1	2	3	5	7
p Value	0.238	0.213	0.067	0.261	0.417	0.564

[Table/Fig-15]: Changes in the cross sectional area (mm^2)



[Table/Fig-16]: (A) Bar graph (B) Line graph: showing the comparison between the two groups indicating canal volume was statistically significant only at 2 mm between the instruments

Interval (mm)	1	2	3	5	7
p-value	0.200	0.037	0.174	0.420	0.333

[Table/Fig-17]: Changes in the Volume (mm^3)

Measurement of canal transportation

The pre and post instrumentation scans were superimposed to allow canal transportation and centring ability to be determined. The dimensions were determined by measuring the shortest distance from the edge of the uninstrumented canal to the edge of the tooth in both mesial (m1) and distal (d1) directions and then was compared with the values measured from the prepared canals (m2 and d2).

The following formula was used for the calculation of transportation: (d1-d2) - (m1-m2)

A result of zero indicated no canal transportation; positive result indicated transportation towards the furcal (distal) aspect of the root and negative result indicated transportation towards the mesial aspect of the root.

Measurement of centring ability

This ratio was calculated for each section using the following formula: (d1-d2) / (m1-m2) or (m1-m2) / (d1-d2)

Gambill et al., defined centring ratio as the measurement of the ability of the instrument to stay centred in the canal.

If these numbers were unequal, the numerator for this formula would be the smaller of the two numbers. A result of one indicated perfect centring ability; the closer the result is to zero, the worse the ability is of the instrument to remain centred.

STATISTICAL ANALYSIS

Mean and standard deviation were calculated. Student t-test was applied to the in root canal curvature, working time, cross sectional area and volume for both the instrumentation techniques. Chi-square test was performed to detect the significant differences in relation to canal transportation and centric ability at the various intervals. The level of significance was set at p= 0.05.

RESULTS

Root canal curvature

The change in the root canal curvature with the different instrumentation techniques was statistically significant ($p < 0.05$). The mean changes are shown in [Table/Fig-6a,b,7].

Working time

The mean time taken to prepare the PF group was 85.06 ± 3.119 seconds, for the VGP2 group was 34.44 ± 2.659 seconds. This is due to the presence of one extra file in the PF group. Therefore the difference was statistically significant in two groups ($p < 0.05$). The mean changes are shown in [Table/Fig-8,9].

Canal Transportation

In the VGP2 group majority of the instrumented canals were transported towards the distal aspect of the root at all the intervals, but there was a slight mesial transportation in the PF group at 0 mm. The overall results indicated the difference between the two groups was statistically significant at all the intervals ($p < 0.05$). The changes are shown in [Table/Fig-10,11].

Centric ability

The difference in the centric ability between the two groups was statistically significant at all the intervals except at 1 mm ($p < 0.05$). The changes are shown in [Table/Fig-12,13].

Cross-sectional area

The increase in cross sectional area when compared between the two instrumentation groups was not statistically significant at any interval ($p > 0.05$). The changes are shown in [Table/Fig-14,15].

Volume

The change in the volume in the groups was statistically significant only at 2mm ($p > 0.05$). The changes are shown in [Table/Fig-16,17].

DISCUSSION

Coronal enlargement [17] and preliminary creation of a glide path are fundamental for safer use of NiTi rotary instrumentation [18,19]. Canal scouting and preflaring are the first phases of canal instrumentation during which the clinician might more frequently find procedural difficulties [20].

Studies suggested that the analysis of modifications in canal curvature after instrumentation is a reliable method to evaluate the tendency of a shaping technique to maintain the original canal anatomy or to straighten the curves [21]. In this study, analysis was performed through observation of changes between preinstrumentation and post instrumentation curvature in the mesial canals in both transverse as well as coronal axis.

Previous studies demonstrated the reliability of the experimental method used and its effectiveness in representing changes in canal curvature and in extrapolating the results The use of a small-size hand K-file followed by a more flexible and less tapered NiTi rotary Path file might be a less invasive and safer method to provide a glide path that better maintains the original canal anatomy, compared with manual preflaring performed with stainless steel K-file [22].

Moreover, preflaring tends to minimize procedural errors such as transportation and ledge formation. Indeed, preflaring permits to maintain a pathway to the full Working Length (WL), avoiding excessive instrument binding in the canal [18,19].

In case of severe curvature, flaring the coronal portion of the root canal should be the procedure of choice in order to facilitate the placement of files into the apical segment [23] and prevent excessive flexural stress to the Ni-Ti instruments [24,25].

In the present study, the preparation time included active instrumentation as well as the time required for changing instruments, cleaning the flutes of the instruments and irrigation to allow comparison of the results with those of previous studies conducted with an identical experimental set-up [26-28].

If the canal preparation in the apical-third of the root is not centred, it might lead to blockages, perforations and ledges. This could result in inadequately cleaned canals with the likelihood of persistent apical perioodontitis [29]. Sauaia et al., [30] found that the distal (furcal) root wall of the mesio-buccal canal of a mandibular molar is thinner in teeth with long roots (24 mm) than in short-rooted teeth (19 mm); it can therefore be justifiably assumed that strip perforations might occur more frequently in mandibular teeth with long roots than short-rooted mandibular teeth. most of the instrumented canals were transported towards the furcal (distal) aspect of the root coronally and the mesial aspect of the root in the mid and apical root sections.

The rationale behind measurement of changes in the cross sectional area was to enable comparisons at standardized cutplanes. Therefore, comparisons with previous work [31], which measured changes in the total area of the root canal system, are difficult. Our results have shown that regardless of the rotary system used, the cross-sectional area increased at all levels. Nevertheless, there was no difference between any rotary systems at any cutplane [32].

The mean pre-instrumentation canal volumes were comparable, indicating similar root canal sizes. The mesio-buccal and mesio-lingual canals were used given that these canals are prone to iatrogenic errors [33] because they are often narrow and have accentuated curves that increase the level of instrumentation difficulty [34]. Canal volume is a variable used to analyse the effects of canal instrumentation on dentine removal [31,35-37]. Overinstrumentation of the root canal could result in excessive thinning of the root. In this study, root canal instrumentation resulted in an increase in canal volume, which improves access of irrigants to the apical-third of the canal, but is also an indication that mechanical debridement might not be as effective apically as it is coronally.

CONCLUSION

Within the limits of this study the rotary Nickel Titanium Path Files appeared to be suitable instruments used in clockwise rotary motion for safe and easy creation of glide path.

REFERENCES

[1] Schilder H. Cleaning and shaping the root canal. *Dent Clin North Am.* 1974;18:269-96.

[2] Sjogren U, Hagglund B, Sundqvist G, Wing K. Factors affecting the long-term results of endodontic treatment. *J Endod.* 1990;16:498-504.

[3] Walia HM, Brantley WA, Gerstein H. An initial investigation of the bending and torsional properties of Nitinol root canal files. *J Endod.* 1988;14:346–51.

[4] Camps JJ, Pertot WJ, Levallois B. Relationship between file size and stiffness of nickel titanium instruments. *Dent Traumatol.* 1995;11:270–73.

[5] Kazemi RB, Stenman E, Spangberg LS. Machining efficiency and wear resistance of nickel-titanium endodontic files. *Oral Surg, Oral Med, Oral Pathol, Oral Radiol, and Endod.* 1996;81:596–602.

[6] Young GR, Parashos P, Messer HH. The principles of techniques for cleaning root canals. *Aust Dent J.* 2007;52:52–63.

[7] Sotokawa T. An analysis of clinical breakage of root canal instruments. *J Endod.* 1988;14:75-82.

[8] Pruett JP, Clement DJ, Carnes DL Jr. Cyclic fatigue testing of nickel-titanium endodontic instruments. *J Endod. 1997;23:77-85.*

[9] Mounce R. An excellent glide path *, the road to smoother endodontics. Oral Health Journal. 2004;94:51-68.

[10] West J. The Endodontic Glidepath: Secrets to rotary success. *Dentistry Today.* 2010;29:86,88,90-93.

[11] Vyver van der Peet. Creating a glide path for rotary NiTi instruments: *part one Int Dent Sa.* 2011;13:6-10.

[12] West J. Manual versus Mechanical endodontic glide path. *Dentistry Today.* 2011;30:136-140

[13] Taylor P. Cotton, Todd M. Geisler, David T Holden, et al. Endodontic Applications of Cone-Beam Volumetric Tomography. *J Endod.* 2007;33:1121–32.

[14] Nair MK, Nair UP. Digital and Advanced Imaging in Endodontics: A Review. *J Endod.* 2007;33:1–6.

[15] Lofthag HS, Huumonen S, Grondahl K, Grondahl HG Limited cone-beam CT and intraoral radiography for the diagnosis of periapical pathology. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 2007;103:114 –19.

[16] Stern S, Patel S, Foschi F, Sherriff M, Mannocci F. Changes in centring and shaping ability using three nickel–titanium instrumentation techniques analysed by micro-computed tomography (μCT). *Int Endod J.* 2012;45:514-23.

[17] Roland DD, Andelin WE, Browning DF, Hsu GH, Torabinejad M. The effect of preflaring on the rates of separation for 0.04 taper nickel titanium rotary instruments. *J Endod.* 2002;28:543–45.

[18] Berutti E, Negro AR, Lendini M, Pasqualini D. Influence of manual preflaring and torque on the failure rate of ProTaper rotary instruments. *J Endod.* 2004;30:228–30.

[19] Patiino PV, Biedma BM, Li_ebana CR, Cantatore G, Bahillo JG. The influence of a manual glide path on the separation rate of NiTi rotary instruments. *J Endod.* 2005;31:114–16.

[20] Jafarzadeh H, Abbott PV. Ledge formation: review of a great challenge in endodontics. *J Endod.* 2007;33:1155–62.

[21] Merrett SJ, Bryant ST, Dummer PM. Comparison of the shaping ability of RaCe and FlexMaster rotary nickel-titanium systems in simulated canals. *J Endod.* 2006;32: 960–62.

[22] Berutti E, Cantatore G, Castellucci A, et al .Use of nickel-titanium rotary PathFile to create the glide path: comparison with manual preflaring in simulated root canals *J Endod.* 2009;35:408–12.

[23] Leeb J. Canal orifice enlargement as related to biomechanical preparation. *J Endod.* 1983;9:463–70.

[24] Pruett JP, Clement DJ, Carnes DL Jr. Cyclic fatigue testing of nickel-titanium endodontic instruments. *J Endod.* 1997;23:77-85.

[25] Sattapan B, Palmara JE, Messer HH. Torque during canal instrumentation using rotary nickel-titanium files. *J Endod.* 2000;26:156-60.

[26] Schafer E, Vlassis M. Comparative investigation of two rotary nickel-titanium instruments: ProTaper versus RaCe. Part 2. Cleaning effectiveness and instrumentation results in severely curved root canals of extracted teeth. *Int Endod J.* 2004;37:239-48.

[27] Burklein S, Schafer E. The influence of various automated devices on the shaping ability of Mtwo rotary nickel-titanium instruments. *Int Endod J*. 2006;39(12):945-51.

[28] Schafer 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.

[29] Gorni FG, Gagliani MM. The outcome of endodontic retreatment: a 2-yr follow-up. *J Endod.* 2004;30:1–4.

[30] Sauaia TS, Gomes BP, Pinheiro ET, Zaia AA, Ferraz CC, Souza-Filho FJ. Microleakage evaluation of intraorifice sealing materials in endodontically treated teeth. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 2006;102:242–46.

[31] Peters OA, Peters CI, Schonenberger K, Barbakow F. ProTaper rotary root canal preparation: effects of canal anatomy on final shape analysed by micro CT. *Int Endod J.* 2003;36:86–92.

[32] Ozgur Uyanik M, Cehreli ZC, Ozgen Mocan B, Tasman Dagli F. Comparative Evaluation of Three Nickel-Titanium Instrumentation Systems in Human Teeth Using Computed Tomography. *J Endod.* 2006;32:668-71.

[33] Abou-Rass M, Frank AL, Glick DH. The anticurvature filing method to prepare the curved root canal. *J Am Dent Assoc.* 1980;101:792–94.

[34] Berutti E, Fedon G. Thickness of cementum/dentin in mesial roots of mandibular first molars. *J Endod.* 1992;18:545–48.

[35] Bergmans L, Van Cleynenbreugel J, Wevers M, Lambrechts P. A methodology for quantitative evaluation of root canal instrumentation using microcomputed tomography. *Int Endod J.* 2001b;34:390–98.

[36] Peters OA, Schonenberger K, Laib A . Effects of four Ni-Ti preparation techniques on root canal geometry assessed by micro computed tomography. *Int Endod J.* 2001;34:221-30.

[37] Peters OA, Boessler C, Paque´ F. Root canal preparation with a novel nickel-titanium instrument evaluated with micro-computed tomography: canal surface preparation over time. *J Endod.* 2010;36:1068-72.

PARTICULARS OF CONTRIBUTORS:

1. Professor & Head, Department of Endodontics, D.J.College of Dental Sciences & Research, Modinagar, U.P., India.
2. Post Graduate, Department of Endodontics, D.J.College of Dental Sciences & Research, Modinagar, U.P., India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Dr. Anil Dhingra,
B-3, New Multan Nagar, New Delhi -110056, India.
Phone : 09868087459, E-mail : dranildhingra39@gmail.com)

FINANCIAL OR OTHER COMPETING INTERESTS: None.

Date of Submission: **Feb 09, 2014**
Date of Peer Review: **May 23, 2014**
Date of Acceptance: **Jun 19, 2014**
Date of Publishing: **Nov 20, 2014**