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# Evaluation of Apical Transportation in Root Canals Prepared with Hand File and Two Rotary Files by Cone Beam Computed Tomography

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## ABSTRACT

*The purpose of the mechanical cleaning of the root canal is to create a conical shape for 3D filling of the canal area. Excessive dentin removal from one side of the canal, as compared to other parts located at an equal distance to the longitudinal axis of the tooth, causes an error called the canal transportation. In this study, the canal transportation was evaluated by hand K-flexo file Mtwo and,Dia-pt rotary file using Cone Beam Computed Tomography (CBCT). This is an Ex-vivo study conducted on 60 extracted first molars. Root curvature was measured by Schneider's method. Preparation was performed in three groups of 20 with manual and Mtwo and Dia-pt files. CBCT images were prepared before and after clearing the canals. Data were analyzed using SPSS 18 Software. Based on the results of the kruskal wallis test, there are differences between the three files in the 2 and 3 mm sections (respectively (p = 0.01) (p = 0.01)). However, there is no difference in the cross-section of 2.5 mm based on kruskal wallis test (p = 0.16). The results of this study indicate that the channel displacement in the Mtwo system is the least. And this system is better than K-Flexo file and Dia-pt in following the shape of the canal and creating a conical canal with the least deviation from the channel.*

**Key words:** Cleaning, Transport, Root Canal Treatment, Mtwo, Dia-pt, Kflexofile

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## INTRODUCTION

The goal of biomechanical root canal preparation is to remove canal contents, specifically microorganisms. This is done by enlarging and shaping the canal to allow for adequate chemical debridement, while preserving the radicular anatomy [1]. During instrumentation; procedural errors such as transportation of the apical foramen or the creation of zips, elbows, ledges can occur along with loss of working length (WL), perforation and separation of instruments [2].

Regardless of the technique used for debridement, this procedure results in removal of root canal walls, to some extent. Removal of more dentin from one side compared to other side of the canal wall which are located at similar distances from the long axis of the root, results in a procedural error known as canal transportation [3]. The shape created due to canal transportation does not provide a resistant form to condense gutta-

percha and results in its poor compaction and over-extension of root canal fillings, which finally leads to failure of the treatment [4].

The introduction of nickel-titanium (NiTi) instruments allowed a safer and easier preparation of canals with complex anatomic characteristics [5]. Files made from nickel-titanium (Ni-Ti) alloy had greater elastic flexibility in bending and torsion and greater resistance to torsional fracture than stainless steel [6, 7]. NiTi rotary instruments are available in different designs and rates of tapering for use in endodontic treatment. [8] Developmental efforts have focused on increasing the cleaning efficacy of the root canal as well as reducing the time spent on preparation-an especially important factor in primary teeth. As a result, a new generation of NiTi rotary instruments-Mtwo endodontic instruments-was developed [9] and introduced in 2003. [10] Mtwo NiTi rotary instruments (VDW, munich, Germany) have an S-shaped cross-section, a nonworking tip, a positive inclination angle, 2 cutting edges, and different tapers. According to the manufacturer, this design prevents fracture and the transportation of debris toward the apex. Each instrument creates an access way for the next sequential instrument, up to the apical region, and all instruments are used up to the working length [9], [11-13].

Dia-pt system (Diadent,Korea) is one of the rotary systems with triangular cross-section that has been not studied yet. The Kerr Company introduce Kflex file (Densply maillefer, Ballaigues, Switzerland) in 1982. Triangle and square cross section has changed the flexibility and the cutting of files [14].

A number of methodologies have been used to evaluate endodontic instrumentation, including plastic models [15], histological sections [16], scanning electron microscopic studies [17], serial sectioning [18, 19], radiographic comparisons [20], and silicon impressions of instrumented canals [21].

Recently, techniques that allow teeth to be evaluated without destroying the specimens have been suggested to compare root canal shape prior to and after instrumentation. With the use of computed tomography (CT), appropriate and measurable sections can be prepared and 3D images can be reconstructed. Root canal instruments and preparation methods can be compared by using CT [22-25].

The aim of this study was to use CBCT images to compare the apical transportation after instrumentation with Mtwo files, Dia-pt files and Kflexo Files.

## MATERIALS AND METHODS

The research protocol was approved by the Ethics committee of Mazandaran University of Medical Sciences, sari Iran (IR.MAZUMS.REC.96.3020**)**. In this experimental *ex-vivo* study 60 extracted human maxillary first molars with completely developed apices. Teeth with immature apices, excessive root carries or radiographic evidence of internal absorption were excluded from the study.

The lengths of mesiobuccal (MB) canals were 14 mm and canal curvature of 20-40 degrees, according to the Schneider's method [26]. Teeth were stored in 0.1% thymol solution at 9 ˚C for disinfect and 24 h before use ,they were stored in normal saline at 4˚C until used, access cavities were prepared and the MB canals were localized. The MB canals were explored with a size #10K-file (Mani, Tochigi, Japen). Until the file tip could be visible from the apex. Then the working length determined by reducing 1mm from this length. Then teeth were mounted in dental stone blocks to facilitate instrumentation the imaging process and maintain reproducibility of the cbct images.

Before starting canal preparation CBCT images (Promax 3D, Helsinki, Finland) were obtained. The 0.5 mm layers of images were taken axially, with 3mm distance from the radiographic apices and perpendicular to the long axis of the roots. After the preparation stage post instrumentation cbct images were obtained exactly similar to what had been done before preparation. The pre-procedure images were recorded to be later compared with post – preparation images.

### Preparation

The teeth were randomly divided randomly to 3 equal groups (n=20). The coronal segment of the canals was prepared using sizes 3-1 Gates-Glidden drills (Dentsply Maillefer, Ballaigues, Switzerland). In addition, 2 mL of 2.5% NaOCl was used during instrumentation of the canals in groups.

**Table 1: Apical transportation at different radiographic sections and p-values**

| Section | Kfelexofile | Dia_pt | Mtwo | P-value K-Flexo file,Dia-pt (Mann–Whitney) | p-value K-Flexo file,Mtwo (Mann–Whitney) | p-value Dia-pt, Mtwo (Mann–Whitney) |
|---|---|---|---|---|---|---|
| 2 mm | 0.23 ± 0.215 | 0.19 ± 0.24 | 0.09 ± 0.225 | 0.4 | 0.003 | 0.046 |
| 2.5mm | 0.23 ± 0.309 | 0.12 ± 0.34 | 0.10 ± 0.165 | 0.16 | 0.16 | 0.16 |
| 3mm | 0.19 ± 0.14 | 0.10 ± 0.13 | 0.06 ± 0.10 | 0.24 | 0.005 | 0.095 |

**Group 1**

In this group 20 canals were prepared with Mtwo (VDW, Munich, Germany) and handpiece using electric motor (endo_matetc, Nsk, nakanishiINC, Tokyo, Japan) set at a speed of 300 rpm and a torque of 3Nm based on manufacturer's instructions. Apical preparation was performed using files with the following sizes (10/0.04, 15/0.05, 20/0.06 and 25/0.06).

**Group 2**

In this group 20 canals were prepared with Dia-pt file (Diadent,Korea) And handpiece using electric motor set at a speed of 300 rpm and a torque of 3Nm based on manufacturer's instructions. Apical preparation was performed using files with following sizes D1, D2, D3, D4 (10-25)

**Group 3**

In this group 20 canals were prepared with hand Kflexo file (Densply maillefer, Ballaigues, Switzerland) using the passive step back technique up to #25 file. Instrumentation was carried out by the same operator in all three groups.each file was used for 5-10 second in canal.in this study MB2 canals were not assessed.
The measurements were made using the method introduced by Gambill et al (1996) as follows:
A1: The minimum distance between the external surface of the root section and the mesial external surface of the uncleaned root canal.
B1: The minimum distance between the external surface of the root section and the distal external surface of the uncleaned root canal.
A2: The minimum distance between the external surface of the root section and the mesial external surface of the cleaned root canal.
B2: The minimum distance between the external surface of the root section and the distal external surface of the cleaned root canal.

The amount of transportation was calculated according to the following formula: [(A1-A2)-(B1-B2)].

After insertion of the values in the formula, if the resultant value was zero, there was apical transportation. Data of the groups were evaluated by the SPSS18 and T-Test, and if the transportation was not normal the data were evaluated by Mann-Whitney and $X^2$.

## RESULTS

Based on the result of Kruskal wallis test there was difference between 3 files at the level of 2 and 3mm (p=0.01) (p=0.017).

However at the level of 2.5mm there was no difference based on Kruskal wallis test (p=0.16).

The apical transportations with Dia-pt, Kflexo file, Mtwo at the level of 2, 2.5 and 3 mm are compared and the results are existing in table 1-3.

In Mann-Whitney test there was no significant difference in comparison of hand files and Dia-pt (at the level of 2 mm with p=0.4 and at the level of 3 mm with P=0.24), but there are differences in comparison between hand files and Mtwo (at the level of 2 mm with P=0.003 and at the level of 3 mm with P=0.005).

Also there were significant differences in comparison between Dia-pt and Mtwo at the level of 2 mm but this difference was not significant at the level of 3 mm.

Based on Kruskal wallis test there were no differences between 3 sections of each file.

**Table 2: Apical transportation at 3 sections of each file**

| File type | Dia-pt | K-Flexo file | Mtwo |
|---|---|---|---|
| P-value | 0.54 | 0.80 | 0.32 |

Apical transportations at 3 levels (2, 2.5, and 3) of each file are exist in figure 3-1. Also you can observe the apical transportation of each section in 3 files in figure 1-2 (hand file=$d_1$ Dia-pt file=$d_2$ Mtwofile=$d_3$ ) ($m_1$ =2 mm, $m_2$ =2.5 mm, $m_3$ =3 mm)

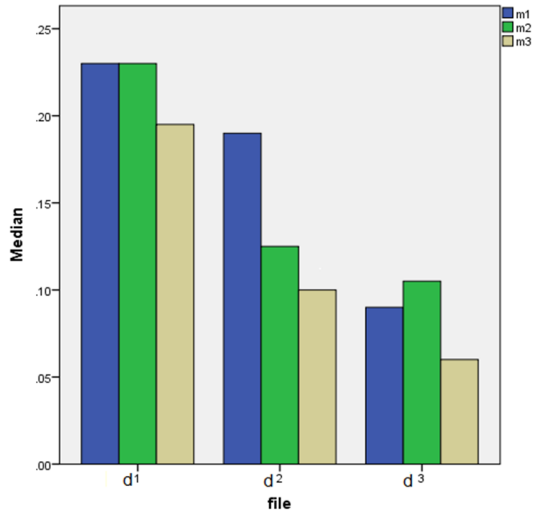


**Figure 1: Apical transportation at 3 levels in studied files**

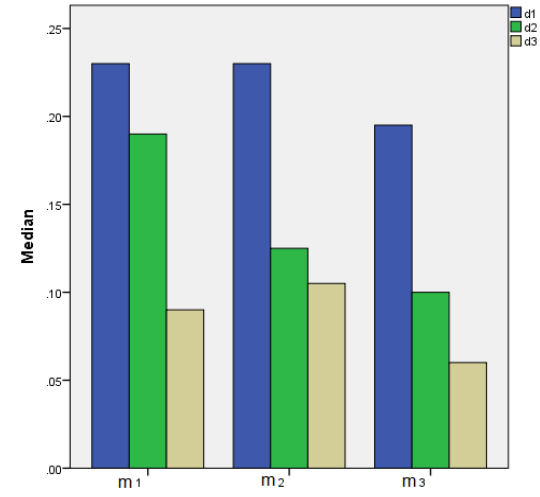


**Figure 2: Apical transportation in studied sections**

## DISCUSSION

CBCT is a kind of computed tomography, in which only a concentrated, cone X-ray beam radiates on the tissues that are supposed to be captured. The resolution of the CBCT image volume can be very low (76μm) which makes very small things visible. Since CBCT provides a three dimensional images, it can be very helpful in diagnosing teeth with complicated anatomies or absorption lesions [4]. CBCT is used in this study for measuring the amount of dentin removal before and after canal preparation during endodontic treatment [27].

We used Dia-pt files in this study because of being new and limited. The result showed that all 3 file systems created apical transportation during root canal preparation; interestingly, there were differences in apical transportation between K-Flexo file, Dia-pt and Mtwo. Also in 2 groups of Dia-pt and Mtwo.there were significant differences at the level of 2 mm.

According to the results, there were not significantly differences between 3files at the level of 2.5mm. However, there were differences between hand files and Mtwo at the level of 2 and 3 mm and the differences between Mtwo and Dia-pt were statistically significant at the level of 2 mm.

On the base on these results, Mtwo system had the capability to maintain the canal centralization more than manual system. Also Mtwo had more capability to maintain the canal centralization than Dia-pt at the level of 3mm. however, the comparison between hand files and Dia-pt. showed no differences for maintaining the canal centralization.

Mtwo files showed less apical transportation than 2 other files, and they could follow the shape of the canal during canal preparation.

Mokhtari *et al*., evaluated the apical transportation of mesio buccal canal of first mandibular in K-Flexo file, Mtwo, or biorace systems by using CBCT. They reported that Mtwo and biorace systems had more capability to maintain the canal centralization than K-Flexo file [28]. Sadeghi et al evaluated the ability of Mtwo, K-Flexo file, and flexmaster in shaping the canal by analyzing images with computer. Results showed that there were no differences between three systems at the level of 1 and 3 mm, but at the level of 5mm K-Flexo file remained centered within the canal, and at the level of 7 and 9 mm Flexomaster and Mtwo had more ability than K-Flexo file[29]. Madani *et al*., assessed the apical transportation in K-Flexo file and K3 using CBCT. In this study 40 mesio buccal canal of first maxillary molar were prepared in two groups. On the base of the results they did not have differences in apical transportation. In the mentioned study there were no differences between rotary system and manual system; the results were not similar to those of the present study and the reason could be the differences in rotary file type [1].

E Schafer *et al*., compared hand file (K-Flexo file) and rotary system (K3) in cleaning and shaping the canal using electronic microscope scan. The

results showed that K-Flexo file had more ability comparing to K3 in preparation the canal; the results were not similar to those of the present study and the reason could be the differences in rotary file type and evalution metod [30]. Ehsani et al evaluated the parameters in shaping the canal with comparing Ni-ti rotary system and manual system using photography. The results showed that Race file had the best capability to maintain the canal centralization among other files. On the other hand Mtwo file prepared the canal in a short time; the results were not similar to those of the present study because it reported the superiority of Mtwo file for being less time consuming, and the reason could be the differences in methods and types of rotary files [31]. Glick et al, evaluated the ability of files (GT X, revo-s, race, protaper universal, K-Flexo file, twisted file,Mtwo) in preparation the canal by modified double-digital radiographic method.

In general Ni-ti rotary system had less apical transportation and changes in working length comparing to K-Flexo file. The results were similar to those of the present study [32]. Young-sil et al assessed the ability of Waveone, Reciproc, K-Flexo file, profile, and protaper files in preparing the canal and photographs were evaluated using microscopy method with a magnification of 4.5. The results revealed that the Ni-ti and K-Flexo file rotary system had no differences in working length changes and preserving the canal curvature, however Ni-ti rotary system had more ability of shaping than K-Flexo file [33]. ShruthiNagaria and colleagues assessed centering ability, transportation, and the amount of remaining dentin thickness after instrumentation using manual Ni-Ti K-file and protaper rotary system. In this study 30 mesiobuccal canal of first molar were evaluated in 2 groups, and canals were compared before and after preparation using CBCT. They concluded that because Protaper files could cause greater extent of canal transportation, they should be used cautiously especially in curved canals [30]. Azar et al, compared the ability of manual K.file and 2rotary files (Protaper and Mtwo) in preparing first permanent molar canals. On the base of results, Mtwo and Protaper were more capable in instrumentation of the canal. The results were similar to those of the present study [34]. Charles r glosson and colleagues compared preparation of canals with manual Ni-Ti, rotary Ni-Ti, and manual K-Flexo file. The results showed that rotary system had less transportation comparing to other systems, and they were similar to the results of the present study, because both of them revealed that rotary system have more ability in preserving the canal curvature [35].

## CONCLUSION

The results of this study revealed that Mtwo system have the minimal canal transportation, and this system is more suitable than K-Flexo file and Dia-pt because of the least deviation from the original canal path and following the shape of the canal.

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**Conflict of Interest**
None declared'.

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