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COMPARISON OF THE SHAPING ABILITY OF DIA-PT ANDPROTAPER-NEXT ROTARY FILE SYSTEMS (AN IN VITRO STUDY)

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ABSTRACT

Introduction: Shaping ability is very important stage in root canal treatment. It aimed to respect the natural curvature of root canal systems and preserve remaining dentin thickness to avoid over cutting of dentin which will cause weakening of the root. **Aim:** To compare shaping ability of two types of rotary systems in terms of Canal transportation, Canal centring and Change in canal curvature. **Methodology:** Fourty extracted human adult mandibular first molars were collected. Sample size used in this study was 40 mandibular molars,(n=40). They were divided into two groups (n=20) Group 1: twenty teeth were prepared by Dia- PT rotary file. Group 2: twenty teeth were prepared by Pro-Taper Next rotary file. Pre-instrumentation CBCT scans were superimposed then the dimensions were measured by calculating the shortest distance from the periphery of the uninstrumented canal to the periphery of the tooth in both mesial and distal directions. Root canal preparation was performed according to their group. After instrumentation, the specimens were scanned again in the same way as described for the pre-instrumentation scan. Recorded data were analyzed using the statistical package for social sciences, version 23.0 (SPSS Inc., Chicago, Illinois, USA). The quantitative data were presented as mean± standard deviation and ranges. **Results:** The Overall recorded statistically significant difference between groups according to values of transportation with p-value, There was no statistically significant difference between groups according to values of canal centering ratio with p-value. **Conclusion:** The new manufacturing method (Controlled memory wire) produced instruments with different microstructure and the process appeared to offer great impact on their clinical performance and the effect of the design of the rotary NiTi instruments can't be neglected or under estimated.

KEYWORDS: Shaping ability. Cone beam CT. Dia-PT rotary files. Pro Taper Next rotary files. Canal transportation. Canal centering. Degree of canal curvature.

INTRODUCTION

The aim of Root canal treatment is to eliminate microorganisms from the rootcanal system. It consists of removing the infected pulp and shaping root canal systems to facilitate irrigation and placement of a medication or permanent filling material. In the last decade, many types of rotary root canal instruments have been introduced with variable design features, motions and metallurgy.

Shaping ability is very important stage in root canal treatment. It aimed to respect the natural curvature of root canal systems and preserve remaining dentin thicknessto avoid over cutting of dentin which will cause weakening of the root.

The role of root canal shaping is the removal of bacteria and infected dentine from within the root canal system and the creation of a smooth progressively tapered preparation that facilitate debridement and subsequent filling to prevent re- infection. The ideal preparation should possess a progressive taper with the original anatomy of the canal maintained; the canal should get narrower as it goes from coronal to apical with the end of the preparation in the original position of the apical foramen and not over enlarged.[1] Using instruments of limited flexibility in canals displaying even the slightest complexity showed tendency to cause various procedural errors such as ledge formation, mid-root strip perforations and transportations. These complications would compromise the ability to adequately seal the canal to guarantee long-term success of the treatment.

When using the traditional rigid stainless -steel hand instruments, it is difficult to respect root canal shape, especially in narrow and curved canals. It is time consuming and there is more chance of getting canal alteration such as elbows, zips, ledges, and perforations. Nickel titanium (NiTi) instruments have been manufactured with new design features such as varying tapers, non cutting safety tips, with varying length of cutting blades and improvement of metallurgical properties of Ni-Ti alloy.[2]

All Ni-Ti rotary systems incorporate instruments with varying tapers ranging from 0.04 to 0.12. In order to improve the low cutting efficiency of Ni-Ti instruments, greater tapering instruments has been introduced to improve the canal shaping ability and to reduce the instrument failures.[3] Several factors can affect the shaping ability of different nickel-titanium (NiTi) files used in endodontics. These factors include file design, metallurgy, cross-sectional geometry, file size, rotational speed, irrigating solutions, and operator technique.[4,5]

Dia-Pt is heat treated Ni-Ti file with triangular cross section which reduces the contact with canal walls. It also has a progressive taper design which increases flexibility and efficiency. Furthermore, it was claimed to have a high corrosion resistance.

Pro-Taper Next is another file manufactured from the M-wire technology and has specific design features. It has a square cross section, variable taper on a single file and a snake-like rotational movement which enhances its flexibility and cutting efficiency.

There is limited research and literature available comparing the shaping ability of ProTaper Next and Dia-PT rotary files. Therefore, the knowledge gap lies in the lack of comprehensive evidence comparing these two systems.

MATERIALS AND METHODS

Fourty extracted human adult mandibular first molars were collected from the outpatient clinic in oral surgery department at Faculty of Dentistry, Ain Shams University. Only teeth with fully developed sound root apices with mesiobuccal rootcanals of (25°– 35°) angle of curvature. Straightening of canal curvature were measured using digital image analysis software. Instrumentation time and instruments failures were also recorded. Schneider's method[1] was used to calculate the angle of mesiobuccal canal curvature by making a point at the orifice (point a), then a straight line was drawn along the straight part of the canal to meet a point where it starts to deviate (point b), then another straight line was drawn from point b to apical foramen (point c). The angle formed by intersection of the two lines was measured as the canal curvature. This was done by using Image J*software but radius of canals measured by CBCT before preparation. Selected teeth were randomly divided into 2 groups; Group 1: twenty teeth were prepared by Dia-PT rotary file. Group 2: twenty teeth were prepared by Pro-Taper Next rotary file.

Shaping ability

1- Canal Transportation

The amount of canal transportation was determined by measuring the shortest distance from the edge of the un-instrumented canal to the periphery of the root (mesiodistal) and then compared with the same measurements obtained from the instrumented images. A double-digital standardized radiographic technique was used to evaluate apical transportation 0.5 mm from the working length "1.5-mm coronal of the major foramen". Transportation and centering ratio were calculated using mathematical formula (M1-M2)-(D1-D2) and (M1-M2)/(D1-D2) respectively developed by Gambill et al.[6]
M1: The shortest distance from mesial edge of the root to the mesial edge of uninstrumented canal.

According to this formula, a result other than 0 indicated that transportation has occurred in the canal.

The following formula of Gambill et al.[6] was used for the calculation of transportation: (M1– M2) - (D1– D2).
M2: The shortest distance from the mesial edge of the root to the mesial edge of instrumented canal.
D1: The shortest distance from the distal edge of the root to the distal edge of the uninstrumented canal.
D2: The shortest distance from the distal edge of the root to the distal edge of the instrumented canal.

Calculation of transportation: Degree of transportation in mesio-distal direction calculated according to the following equation (Ml - M2) - (D 1 - D2)[42] (Figure 7). A result of zero means no canal transportation, other results than zero means deviation of the canal.

2- Centring Ability

Measurement of pre- and post-instrumentation dentin thickness:
Three cross-section planes at levels 3, 5 and 8 mm from the apical end of the root were viewed through the explorer mode. The shortest distance from the canal wall to the external root surface was measured in the mesial and distal directions for the mesiobuccal root canal. The distance was measured on the reconstructed 2-dimensional image without reduction by using the measure length tool. The recorded data pre operatively represents Ml and Dl while the recorded data post operatively represents M2 and D2.[7]

Calculation of centering ratio: Centering ratio calculated according to Gambill et al[2] The ratio was calculated for both groups mesio-distally using the following formula:(M1-M2) / (Dl-D2)

If these numbers are not equal, the lower figure is considered the numerator of the ratio. According to this formula, a result of 1 indicates perfect centering.

3- Degree of curvature of the canals

The degree of curvature of root canals was calculated =

$$\frac{precurvaturedegree - postcurvaturedegree}{precurvaturedegree}\%$$

We aimed by our study to compare Dia-Pt &Pro-Taper Next rotary files regarding their: Shaping ability (canal transportation, canal centering and change of canal curvature) using cone beam computed tomography (CBCT).

Root canal preparation

It was performed according to their group

Group1(The Dia group): The coronal shaping was done using Dx file to enlarge the opening of the canals then follow the glide path using K file #15. The middle and apical portions were shaped using D1 file to the full working length using gentle apical force to brush laterally. Then, useD2 file to enlarge apical 2/3 with gentle brushing action. Using D3 file down to the apex with an in-out pecking motion (this file matches the size of K-file #20). Finally, The final shaping was done by D4(matches K-file #25) and D5(matches K-file #30) files to enlarge the apex of root canals. The root canal was irrigated with 2 ml 2.5% sodium hypochlorite and EDTA 19% solutions after each file instrumentation.

Group2 (The Pro Taper Next group): the coronal shaping was done using Sx fileto open the orifice of the canals then follow the glide path using K file #15. The middle and apical portions were shaped using X1 file (matches K-file #20) to the full working length using gentle apical force to brush laterally. Then, use X2(matches K-file #25) and X3(matches K-file#30) files to enlarge the apex ofroot canals. the root canal was irrigated with 2 ml 2.5% sodium hypochlorite and EDTA 19% solutions after each file instrumentation.

Post Instrumentation imaging using CBCT and measurements: After instrumentation, the specimens were scanned again in the same way as described for the pre-instrumentation scan.

RESULTS

The results of the present study are demonstrated in the tables (1-5) and figures (1-2)

Shaping Ability

A) Transportation

1- Group 1 recorded the highest value of transportation with p-value (p=0.043) at cervical area compared to Group 2 (0.1095±0.0763) which means there was statistically significant difference between groups.
2- At the Middle third showed there is no statistically significant difference between groups according to values of transportation with p-value (p=0.171). The highest value was found in Group 1 (0.1390±0.1025) compared to Group 2 (0.1005±0.0687).
3- At the apical third showed there was statistically significant difference between groups according to values of transportation with p-value (p=0.003). The highest value was found in Group 1(0.1705±0.1275) compared to Group 2 (0.0725±0.0499).
4- The Overall recorded statistically significant difference between groups according to values of transportation with p-value (p<0.001). The highest value was found in Group 1 (0.1663±0.0674) compared to Group 2 (0.0942±0.0347).

Table 1: Effect of file type on canal transportation.

Canal Transportation	Group 1 Dia-PT	Group 2 ProTaper Next	p-value
Cervical	0.1895±0.1524	0.1095±0.0763	0.043*
Middle	0.1390±0.1025	0.1005±0.0687	0.171
Apical	0.1705±0.1275	0.0725±0.0499	0.003*
Overall	0.1663±0.0674	0.0942±0.0347	<0.000**

*p-value >0.05 NS; *p-value <0.05 S; **p-value <0.001 HS*

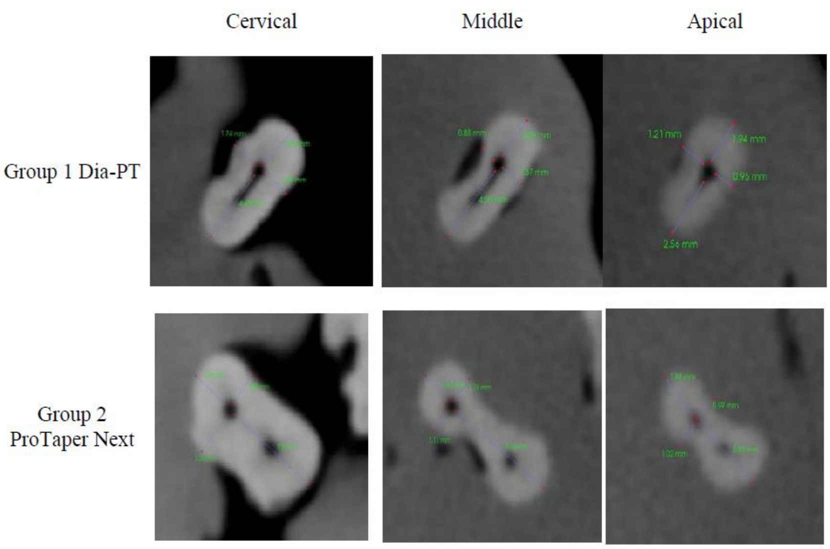


Fig. 1: CBCT axial view showing effect of file type on canal transportation and centering in 3zones.

1- Group 1 recorded no statistically significant difference between thirds of the canals according to values of transportation with p-value (p=0.688). The highest value of transportation was measured at Cervical third (0.1895±0.1524) followed by that measured t apical third (0.1705±0.1275) and the lowest value was measured at middle third (0.1390±0.1025).

2- Group 2 recorded no statistically significant difference between thirds of the canals according to values of transportation with p-value (p=0.095). The highest value of transportation was measured at Cervical third (0.1095±0.0763) followed by that measured at middle third (0.1005±0.0687) and the lowest value was measured at apical third (0.0725±0.0499).

Table (2): Effect of canal third on canal transportation in each group.

Canal Transportation	Group 1 Dia-PT	Group 2 ProTaper Next
Cervical	0.1895±0.1524[a]	0.1095±0.0763[a]
Middle	0.1390±0.1025[a]	0.1005±0.0687[a]
Apical	0.1705±0.1275[a]	0.0725±0.0499[a]
ANOVA test	**0.167**	**3.089**
p-value	**0.688**	**0.095**

Using: Repeated measurement ANOVA
Means that do not share same letter are significantly different p-value >0.05 NS

B) Canal centering ratio

1- At the Cervical third was no statistically significant difference between groups according to values of canal centering ratio with p-value (p=0.648). The highest value was found in Group 2 (1.2096±0.7918) compared to Group 1 (1.0747±1.0461).

2- At the Middle third was no statistically significant difference between groups according to values of canal centering ratio with p-value (p=0.426). The highest value was found in Group 1 (1.8524±1.2275) compared to Group 2 (1.5624±1.0431).

3- At the Apical third was no statistically significant difference between groups according to values of canal centering ratio with p-value (p=0.192). The highest value was found in Group 1 (1.1894±1.3423) compared to Group 2 (0.7520±0.6066).

4- The Overall was no statistically significant difference between groups according to values of canal centering ratio with p-value (p=0.279). The highest value was found in Group 1 (1.3721±0.6160) compared to Group 2 (1.1746±0.5168).

Table 3: Effect of file type on canal centering ratio.

Canal centering ratio	Group 1 Dia-PT	Group 2 ProTaper Next	p-value
Cervical	1.0747±1.0461	1.2096±0.7918	0.648
Middle	1.8524±1.2275	1.5624±1.0431	0.426
Apical	1.1894±1.3423	0.7520±0.6066	0.192
Overall	1.3721±0.6160	1.1746±0.5168	0.279

Using: Independent Sample t-test p-value >0.05 NS

1- Group 1 recorded statistically significant difference between cervical and middle according to values of canal centering ratio with p-value (p=0.032). The highest value of canal centering ratio was measured at Middle third (1.8524±1.2275) followed by that measured at apical third (1.1894±1.3423) and the lowest value was measured at cervical third (1.0747±1.0461).

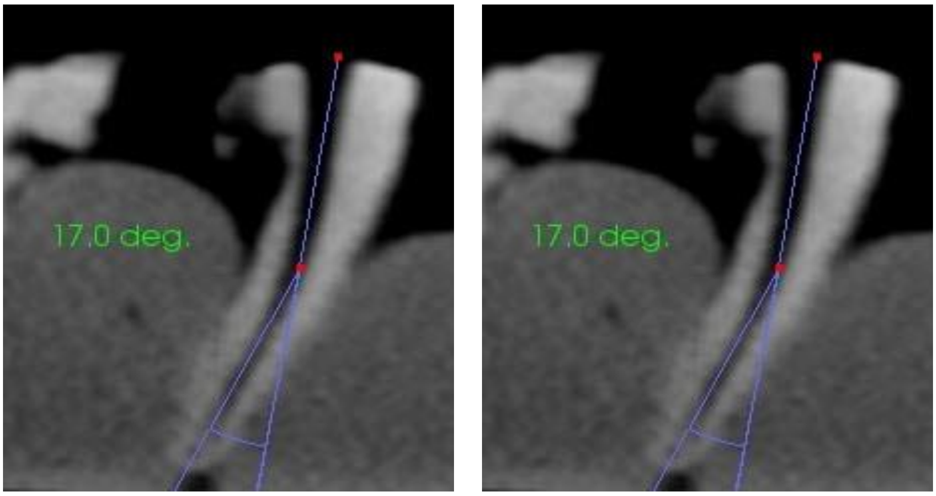
2- Group 2 recorded statistically significant difference between apical and the other two thirds according to values of canal centering ratio with p-value (p=0.049). The highest value of canal centering ratio was measured at Middle third (1.5624±1.0431) followed by that measured at cervical third (1.2096±0.7918) and the lowest value was measured at apical third(0.7520±0.6066).

Table 4: Effect of canal third on canal centering ratio in each group.

Canal centering ratio	Group 1 Dia-PT	Group 2 ProTaper Next
Cervical	1.0747±1.0461 [b]	1.2096±0.7918 [a]
Middle	1.8524±1.2275 [a]	1.5624±1.0431 [a]
Apical	1.1894±1.3423 [ab]	0.7520±0.6066 [b]
ANOVA test	**5.372**	**4.402**
p-value	**0.032***	**0.049***

Using: Repeated measurement ANOVA
*Means that do not share same letter are significantly different p-value >0.05 NS; *p-value <0.05S; **p-value <0.001 HS*

There is no statistically significant difference between groups according to values of degree of curvature of root canals% with p-value (p=0.525). The highest value was found in Group 2 (16.6555±9.3682) compared to Group 1 (14.6150±10.6836).



Group 1 Dia-PT **Group 2 ProTaper Next**

Fig. 2: CBCT sagittal view showing degree of canal curvature.

Table 5: Comparison between Dia-PT and ProTaper-Next according to degree ofcurvature of root canals%.

Degree of curvature of root canals%	Group 1 (n=20)	Group 2 (n=20)	p-value
Mean±SD	14.6150±10.6836	16.6555±9.3682	0.525

Using: Independent Sample t-test p-value >0.05 NS

DISCUSSION

Root canal shaping is crucial for successful presentation of natural canal anatomy and apical curvatures and avoiding procedural errors such as transportation, ledges, zipping, and elbowing.[8]

Root canal instrumentation aims to form a continuously tapered shape with the smallest diameter at the apical foramen and the largest at the orifice to allow effective irrigation and filling according to Schilder.[9]

The introduction of nickel-titanium (NiTi) rotary instruments enhanced the quality of canal shaping with several properties. Numerous root canal shaping techniques using different NiTi systems have been suggested to maintain the original shape of the canal. Hence the aim of the study was directed to compare the newly introduced in market heat-treated instruments Dia-PT files was compared against the ProTaper Next with conventional alloy as a gold standard regarding their shaping by the analysis of transportation, centering ability.

Dia –PT rotary files have several properties, they designed with progressively tapered for instrumentation of curved and calcified canals, also they have triangular cross section that is designed to reduce the file's contact with the canal wall, thus improve safety by decreasing the torsional load. They are flexible NITI rotary files and anti- corrosion coating. They have a variable taper for increase cutting efficiency and showed a low degree of toughness and significantly higher number of cycles to failure.[10]

Regarding canal transportation results in the present study there was statistically significant difference apically and overall between groups according to values of transportation on file type. The highest value was found in Dia-PT group compared to ProTaper-Next group, this came in agreement with ***Moe et al.***[11] who claimed that PTN produced less amount of transportation than PTU at 3 mm level, all 3 file systems showed similar level of canal volume change and transportation.by using Thirty canals with 20°–45° of curvature from extracted human molars were used. Root canal instrumentation was performed with VB, PTN, and PTU files and the amount and direction of canal transportation at 1, 3, and 5 mm from the root apex were measured by using micro-computed tomography. This could be due to instruments with offset mass of rotation showed better root canal shaping ability compared with an instrument with a centered mass of rotation.

Conversely, Gagliardi et al[12] noted that there was no difference in the incidence of canal aberration between ProTaper Next and Protaper universal and by using micro CT Differences in measured parameters were small and did not appear to influence the system's ability to shape moderately curved root canals. This finding corroborates previous literature that showed plastic deformation of instruments after clinical use as a result of the thermal pretreatment of the alloy.[13] However, others have showed that PTN removed similar amounts of dentin as PTU.[14] Interestingly, recent data on cutting efficiency of conventional and martensitic NiTi instruments showed the ''softer'' martensitic alloy was the most efficient instrument in lateral action.[15]

In accordance with our results, a study by ***Madani et al.***[16] agreed with our results and Evaluated Centering Ability and transportation of ProTaper and Neoniti Instruments using CBCT, based on the root wall removal extent canal transportation and centering ability were estimated in both groups and compared. There was no significant difference between the two groups in both canal transportation and centering ability. In this study, a high resolution was selected that was one of the most accurate ones in the literature.[11,16] As an advantage, this study was conducted on natural teeth, therefore its results could be better generalizable to the clinical practice. Finally, all previous studies had only compared different systems with each other.

Conversely, ***Pansheriya et al.***[17] evaluated new nickel-titanium files effect on the canal centric ability and apical transportation on extracted molars using cone-beam computed tomography, canal prepared by V-taper file system. Pre and post- preparation scans are done for all samples using CBCT. It was noticed that Group I (PTN) showed notable lower mean apical transportation and canal centric ability when compared to other groups.

According to canal centering ratio in each group of canal third, Dia-PT showed significant difference between cervical and middle according to values of canal centering ratio. The highest value of canal centering ratio was measured at Middle third followed by that measured at apical third and the lowest value was measured at cervical third.

But Pro-Taper-Next: There was a statistically significant difference between apical and the other two thirds according to values of canal centering ratio. The highest value of canal centering ratio was measured at Middle third followed by that measured at cervical third and the lowest value was measured at apical third.

Through the analysis of centering ability, it is possible to evaluate the symmetry of shaping. This is very important during clinical shaping procedures to avoid formation of iatrogenic lesions.[18]

CONCLUSION

The results concluded that there was statistically significant difference between the two different rotary systems in canal transportation, and centering ability at the apical third of the canals which showed the highest value in Dia PT samples. The new manufacturing method (Controlled memory wire) produced instruments with different microstructure and the process appeared to offer great impact on their clinical performance and the effect of the design of the rotary NiTi instruments cannot be neglected or under estimated.

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