***Original article:***

# A Comparative evaluation of three different Ni-Ti rotary files using Crown Down technique." An *Ex-vivo* study using C T scan.

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**Abstract**

***Objective*:** This ex-vivo study evaluated and compared the canal transportation of the prepared root canals and centering ratio maintained by Mtwo, Protaper and Twited Ni-Ti rotary files using Crown-Down technique**.** ***Materials and Method***: Thirty non-carious extracted permanent human maxillary central incisors without any fracture and having Vertucci type I canal configuration were selected. The teeth were divided into 3 groups each group comprising of ten teeth. All the teeth were mounted on a wax block and pre instrumented canal CT Scan was performed. Access cavity preparation was done in group samples and canal was prepared using crown down technique by Mtwo, Protaper and Twisted NiTi Rotary file systems for the respective groups. Image analysis was done at 9 levels to access transportation and centricity ratio from pre and post instrumented CT scan images. The results showed that Software program determined the volume of pre and post instrumented canals. ***Results***: The Canal transportation occurred least in root canals prepared by Twisted files, followed by canals prepared by Mtwo files and Protaper files. Centricity ratio was maintained the best in root canals prepared by twisted files. ***Conclusion****:* Within the parameters of this study, canals prepared by Twisted Files showed a well centered preparation and maintained the original shape of the root canal without any aberrations.

**Keyword:** NiTi Rotary files; Canal shaping; Canal transportation; Centering ratio.

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## Introduction

Biomechanical preparation, is recognized as being one of the most important stages in root canal treatment.[1,2]It thoroughly cleans and shapes the canals by removing the vital or necrotic tissues.This is carried out by enlarging and shaping the canal to allow for adequate chemical debridement, while preserving the radicular anatomy.[3] Regardless of the instrumentation technique, cleaning and shaping procedures invariably lead to dentine removal from the canal walls.[3] However, excessive dentine removal in a single direction within the canal rather than in all directions equidistantly from the main tooth axis causes canal transportation.[4]

Historically, there have been two major techniques to clean and shape root canals: step-back and crown-down.[5,6] The step-back preparation results in a conservative apical preparation with coronal flaring but is also associated with certain limitations such as being time-consuming and procedural errors.[5] On the other-hand, crown-down technique initially shapes the coronal third while the apical preparation is carried out later. This is beneficial because it allows for early removal of coronal dentin, often the major restrictor to achieving and maintaining working length throughout any cleaning and shaping procedure.[6]

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## Methodology

The present study was conducted in the Department of Conservative Dentistry and Endodontics, Babu Banarasi Das College of Dental Sciences, Lucknow, India and in collaboration with Raydent Imaging Centre, Lucknow. Thirty freshly extracted non carious permanent human maxillary central incisors were selected. The fractured teethor lacking vertucci type I canal configuration were excluded. Maxillary central incisors were extracted due to periodontal reasons. Due to high prevalence of vertucci type I canal morphology and its easy availability the maxillary central incisors were chosen. Randomly all the teeth were divided into 3 groups, each comprising of ten teeth samples. Teeth were stored in 10% formalin until further used.All the teeth were mounted on a block made of wax sheet and this was placed in Siemens CT Scanner.[7] It was aligned so that the long axis of the roots were perpendicular to the beam. The teeth were scanned using 1.0 mm thick slices. It provides 1.0.mm thick axial sections and reconstruction tools for maximum intensity projection and volume rendering (volume reconstruction by intensity 3 D). The pre-instrumented CT scans were made with a Bone Tissue window (120Kv and 90mA), 1.0 mm thick axial sections with 1.0 mm increments, 0.9 pitches, 207 mm display field of view, and beam incidence at the central portion on the device used to fix the specimens. After obtaining pre-instrumentation CT scans of all teeth reconstructions of the 1.0 mm thick axial sections were performed, which provided better image definition.

**Ethical approval:** This study was approved by ethical committee of Babu Banarasi Das College of Dental Sciences, Lucknow, India

### Canal instrumentation

After the pre-instrumented scan, the teeth samples of all the three groups were individually removed from the block made of wax sheet. They were hand held and were prepared using Crown Down technique by Mtwo (VDW, Munich, Germany), Protaper (Dentsply, Maillefer, Ballaigues, Switzerland) and Twisted files (SybronEndo, Orange, CA, USA). First the access cavities were prepared, and the canals were located and explored with an ISO size 10 K File, which were passively advanced into the canals until the tip of the instrument penetrated and adjusted to the apical foramen. The actual canal length was recorded, and the working length was calculated by subtracting 1 mm from this measurement. The canals were instrumented at a speed of 350 rpm using a 16:1 reduction hand piece powered by Endo motor(X Smart, Dentsply, Switzerland). The final apical preparation was set to ISO no 25. Copious Irrigation was done with 3 % Sodium Hypochlorite after the use of each file. 15% EDTA Glyde (Dentsply, Switzerland) was used as a lubricant before and after use of each file.

**GROUP 1 (Mtwo Ni-Ti files)**

The instrumentation sequence according to the manufacturer's instructions was as follows:

1. 0.04 taper size 10 instrument was used to the full length of the canal.
2. 0.05 taper size 15 instrument was used to the full length of canal.
3. 0.06 taper size 20 instrument was used to the full length of canal.
4. 0.06 taper size 25 instrument was used to the full length of canal.

**GROUP 2 (Protaper Ni-Ti files)**

The instrumentation sequence according to the manufacturer's instructions was as follows:

SX File (tip size: 19; tapers: 3.5–19%) used to taper of the coronal part of the canal.

Shaping File No. 1 (tip size: 17; tapers: 2–11%) used to the full length of canal.

Shaping File No. 2 (tip size: 20; tapers: 4–11.5%) used to the full length of canal.

Finishing File No. 1 (tip size: 20; tapers: 5.5–7%) used to the full length of canal.

Finishing File No. 2 (tip size: 25; tapers: 5.5–8%) used to the full length of canal.

**GROUP 3 (Twisted Ni-Ti files)**

The instrumentation sequence according to the manufacturer's instructions was as follows:

Twisted File size 25 taper .08 used to shape the coronal one third or two thirds of the root canal. Twisted File size 25 taper .06 used to shape the canal until 2 mm short of working length. Twisted File size 25 taper .04 used to shape the canal till working length.

Twisted File size 25 taper .06 used to shape the canal till working length.

Twisted File size 25 taper .08 used to shape the canal till working length.

The instrumented canals were scanned using CT as done for the pre-instrumented canal with the same parameters settings. Dicom software was used to

record the image. The final measurements were done through proprietary software of CT scan system.Same computer settings and viewing parameters were used to view the preoperative and post-operative images. Cross sectional images of each tooth were produced at 9 levels from the apex with the help of CT scan software. Each cross-sectional image represented a 1.0mm thick slice through the teeth, perpendicular to the long axis at the particular level.

For the evaluation of canal transportation in Buccolingual(BL) as well as Mesiodistal(MD) direction was observed by the following formula.[15]

BL direction = $(X_1 – X_2) – (Y_1-Y_2)$

MD direction = $(A_1-A_2) - (B_1-B_2)$

$X_1$ represented the longest distance from the buccal surface of the Root to the periphery of pre instrumented canal.

$X_2$ represented the longest distance from the buccal surface of the Root to the periphery of post instrumented canal.

$Y_1$ represented the longest distance from the Lingual surface of the Root to the periphery of pre instrumented canal.

$Y_2$ represented the longest distance from the Lingual surface of the Root to the periphery of post instrumented canal.

$A_1$ represented the shortest distance from the Mesial surface of the Root to the periphery of pre instrumented canal.

$A_2$ represented the shortest distance from the Mesial surface of the root to the periphery of post instrumented canal.

$B_1$ represented the shortest distance from the Distal surface of Root to the periphery of pre instrumented canal.

$B_2$ represented the shortest distance from the Distal surface of the root to the periphery of post instrumented canal.

The result of zero from the canal transportation indicated no canal transportation.

The mean centering ratio was calculated for each section by the formula:

$(X_1-X_2) / (Y_1-Y_2)$ or $(Y_1-Y_2) / (X_1-X_2)$

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

## Observation & Results

### Canal Transportation:

**Table1:** Analysis of Mean Canal Transportation by different files (Apical Third Region)

| N=10 | Mtwo | | Protaper | | Twisted | |
|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Mean | SD |
| S1 | 0.33 | 0.14 | 0.84 | 0.34 | 0.12 | 0.03 |
| S2 | 0.28 | 0.12 | 0.78 | 0.42 | 0.14 | 0.06 |
| S3 | 0.30 | 0.10 | 0.80 | 0.32 | 0.18 | 0.03 |

The above table shows the Mean and standard Deviation ratio of the files in the 3 different sections of the apical third region(S1 to S3).

Table 2: Comparison of the Mean Canal transportation of different files **(Apical Third Region)**

| | S1 | | | S2 | | | S3 | | |
|---|---|---|---|---|---|---|---|---|---|
| | T | P | significant | T | P | significant | T | P | significant |
| Mtwo V / s Protaper | 3.92 | <0.001 | Sig. | 3.66 | <0.001 | Sig. | 4.77 | <0.001 | Sig. |
| Mtwo V / s Twisted | 3.07 | <0.001 | Sig. | 3.34 | <0.001 | Sig. | 3.68 | <0.001 | Sig. |
| Protaper V / s Twisted | 7.42 | <0.001 | Sig. | 4.83 | <0.001 | Sig. | 6.17 | <0.001 | Sig. |

Table 3: Analysis of the Mean Canal transportation of different files **(Middle Third Region)**

| N=10 | Mtwo Mean | SD | Protaper Mean | SD | Twisted Mean | SD |
|---|---|---|---|---|---|---|
| S1 | 0.31 | 0.21 | 0.72 | 0.26 | 0.10 | 0.06 |
| S2 | 0.26 | 0.15 | 0.68 | 0.30 | 0.12 | 0.08 |
| S3 | 0.26 | 0.12 | 0.70 | 0.32 | 0.14 | 0.04 |

Table 4: Comparison of the Mean Canal transportation of different files.**(Middle Third Region)**

| | S1 | | | S2 | | | S3 | | |
|---|---|---|---|---|---|---|---|---|---|
| | T | P | Signifi-cant | T | P | Signifi-cant | T | P | Significant |
| Mtwo V/s Protaper | 3.93 | <0.001 | Sig | 4.01 | <0.001 | Sig | 4.12 | <0.001 | Sig |
| Mtwo V/s Twisted | 3.08 | <0.001 | Sig | 2.63 | <0.001 | Sig | 3.04 | <0.001 | Sig |
| Protaper V/s Twisted | 7.44 | <0.001 | Sig | 5.77 | <0.001 | Sig | 5.56 | <0.001 | Sig |

Table 5: Analysis of the Mean Canal transportation of different files **(Cervical Third Region)**

| N=10 | Mtwo Mean | SD | Protaper Mean | SD | Twisted Mean | SD |
|---|---|---|---|---|---|---|
| S1 | 0.24 | 0.12 | 0.60 | 0.26 | 0.08 | 0.03 |
| S2 | 0.22 | 0.14 | 0.54 | 0.24 | 0.10 | 0.08 |
| S3 | 0.20 | 0.10 | 0.64 | 0.34 | 0.12 | 0.04 |

Table 6: Comparison of the Mean Canal transportation of different files. **(Cervical Third Region)**.

| | S1 | | | S2 | | | S3 | | |
|---|---|---|---|---|---|---|---|---|---|
| | T | P | Significant | T | P | Significant | T | P | Signifi cant |
| Mtwo V/s Protaper | 4.02 | <0.001 | Sig | 3.68 | <0.001 | Sig | 3.97 | <0.001 | Sig |
| Mtwo V/s Twisted | 4.13 | <0.001 | Sig | 2.38 | <0.001 | Sig | 2.37 | <0.001 | Sig |
| Protaper V/s Twisted | 6.36 | <0.001 | Sig | 5.56 | <0.001 | Sig | 4.86 | <0.001 | Sig |

**Centricity Ratio:**

Table 7 : Centricity ratio at middle third of root.

| N=10 | Mtwo No: | % | Protaper No: | % | Twisted files No: | % |
|---|---|---|---|---|---|---|
| Not Mantained | - | - | - | - | | - |
| Manintained | 10 | 100% | 10 | 100% | 10 | 100% |

**Inference:**In the middle third, centricity ratio was maintained equally well with no significant difference in the root canals prepared by Twisted, Mtwo&Protaper files and least by stainless steel files.

Table 8 : Centricity ratio at coronal third of root.

| N=10 | Mtwo | | Protaper | | Twisted files | |
|---|---|---|---|---|---|---|
| | No: | % | No: | % | No: | % |
| Not Mantained | - | - | - | - | | - |
| Manintained | 10 | 100% | 10 | 100% | 10 | 100% |

Table 9: Centricity ratio at Apicalthird of root.

| N=10 | Mtwo | | Protaper | | Twisted files | |
|---|---|---|---|---|---|---|
| | No: | % | No: | % | No: | % |
| Not Mantained | 1 | 10% | 2 | 20% | | - |
| Manintained | 9 | 90% | 8 | 80% | 10 | 100% |

## Discussion

The present study evaluated and compared canal preparation using ProTaper, Mtwo and Twisted files rotary NiTi for canal transportation and centering ability assessed by Computerized tomography.

In the majority of previous researches using Ni-Ti systems, a superior ability to maintain root anatomy even in severely curved canals has been described. [16,17,18,19] However, other studies reported no difference between Rotary Ni-Ti systems and Stainless Steel hand Instruments regarding root canal transportation.[20] These divergent outcomes can be attributed to the difference in methodologies, methods of assessment, instrumentation and preparation techniques.

Rotary preparation with Ni Ti instruments resulted in high quality canal preparations besides having a potential of speeding up the process of canal preparation.[17] These positive characteristics may also be due to the increased taper of the instruments itself, which would definitely facilitate filling with gutta-percha throughout the full volume of the canal. The manufacturer also stated that the 2% taper on conventional ISO instruments is insufficient for optimum preparation of root canals.[16,18]

In this present study, for all the techniques used, no perforations were created during preparation. It can therefore be inferred that the Ni Ti instruments could negotiate and prepare the range of canal shapes at the end-point without any difficulty. Presumably the great flexibility of the Nickel-Titanium alloy and the safe tips of the instruments were largely responsible for the lack of these aberrations and this confirms that even in simulated canals made of relatively soft resin, these Rotary instruments were superior to Stainless Steel hand Files.[21,22]

When comparing the shaping ability of different preparation techniques of different root canal instruments, it is of importance to have similar apical preparation diameters.[23]In the present investigation, the final apical diameter was set to ISO size 25 file. All the selected teeth were submitted to CT scan for evaluation. Recently, Computed Tomography evolved into an exciting tool for experimental Endodontology.[24] No destructive sectioning of specimen is required and there is no loss of root material during sectioning, which could affect results. Each cut plane is an exact section ofthe specimen at right angles to the root canal. The CT scan allows easy measurement of canal changes as each image has an accurate scale, decreasing the potential of Radiographic or photographic transfer error. The cost of CT scan is a consideration which currently inhibits the universal utilization of this methodology.

Various studies investigated rotary root canal preparations. They showed that Ni-Ti maintained original canal shape better than stainless steel hand files.[25,26,27,28,29,30] In the present study, an evaluation and comparison between instruments produced by using the twisting method (TF) versus instruments produced with the traditional Ni-Ti grinding process (M-two and ProTaper) was performed to evaluate canal transportation and centering ratio. With similar apical preparation diameter, the results showed that Twisted Files significantly produced the least transportation and a better centering ratio, followed by the Mtwo and the ProTaper system.

The Mtwo instruments sequence finished with an instrument 6% taper and determined minor apex transportation; regarding the ProTaper, whose last instrument introduced was 8% taper (therefore less flexible), with a risk of apex transportation. The ProTaper system demonstrated a tendency to straighten curved canals. These results were

in accordance with previous studies.[31, 32, 33, 34] The fact that ProTaper system remained less centered and transported more canal preparations might be because of the variable tapers along the cutting surface of these files, in combination with the sharp cutting edges because of their cross-sectional design. Twisted Files instruments a centered preparation and maintained the original shape of the curved canal. Because Twisted Files are manufactured by twisting Ni-Ti wire, the better shaping results can be explained by the fact that Twisted Files are more flexible than Ni-Ti grinded instruments.

Schafer and Vlassis concluded from their study on the relationship between taper size and flexibility that Ni-Ti files with tapers greater than 0.04 should not be used for apical enlargement of curved canals.[34] This study revealed that 0.08 tapered Twisted Files could be used for apical preparation without creating severe aberrations when using less tapered files before the 0.08 tapered ones.

Within the parameters of this study, Twisted Files produced significantly less transportation and remained centered around the root canal to a greater degree than did the other techniques; the reasons for this could be because TF has a triangular cross-section that enhances flexibility and generates less friction inside the canal walls due to a lack of peripheral lands. Moreover, it has a variable pitch that minimizes the "screw-in" effect and allows debris to be effectively channelledout of the canal due to flute widths and flute depths that become accentuated towards the hand piece. Also, a proprietary surface conditioning is there that helps in maintaining the surface hardness of thematerial and sharpness of the edges.

## Conclusion

Within the parameter of this study, according to the results obtained it can be stated that NiTi rotary Twisted Files can be used for canal preparation without creating severe aberrations and providing a well centered preparation.

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