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# DEBRIS EXTRUSION OF THREE NICKEL-TITANIUM ROTARY INSTRUMENTS USING DIFFERENT IRRIGATION PROTOCOLS (IN VITRO STUDY)

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## *ABSTRACT*

**Background:** One of the main objectives of the root canal treatment is the shaping and cleaning of the root canal without changing the outline of the root canal from the preoperative shape. Nickel Titanium files are some of tools used in producing proper cleaning and shaping of the canal. These files have different designs and type of motion that vary in its shaping and cleaning ability.

**Objective:** To evaluate the debris extrusion of dentin after the use of 3 different NiTi filling systems with different irrigations.

**Materials and Methods:** This study was concerned with comparing and evaluation the amount of apical extrusion of debris after preparation with three files systems using quantitative method by pre and post preparation weighting of the tubes collecting the apically extruded debris during the canal preparation.

**Results:** These results might be due to the viscosity of MTAD which is higher than hypochlorite. This may cause entrapment of the dentin debris inside the canal and prevent its extrusion from the apex and the great taper of M Pro files (25# .06 taper) with it's rotational movement so it touch all the canal walls with a great dentine removal.

**Conclusion:** In view of the results of the present study, the following conclusions can be drawn**:** Highest debris extrusion produced with using M-pro files**.** NaOCl produced more cleaning and shaping than MTAD than Saline. Lowest debris extrusion produced with using 2shape files.

**KEYWORDS:** MTAD, M-PRO, PROTAPER, 2-SHAPE

## INTRODUCTION

The elimination of intra-canal microorganisms is essential for the long term success of root canal treatment. This is gained through mechanical cleaning and shaping in combination with irrigation with antibacterial agents.

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The cleanliness of the root canal is one of the most important goals for successful endodontic treatment as well as avoiding periapical inflammation during cleaning and shaping.

The introduction of rotary nickel-titanium instruments has greatly affected endodontic cleaning and shaping procedures. When NiTi instruments were first introduced to endodontics, they were recommended as a substitute to stainless-steel files.

They stay more centered in the canal, produce rounder preparation and reduce procedural accidents as transportation and ledging. Nickel-Titanium rotary systems such as M-pro Files and 2-Shape Files have significantly changed root canal instrumentation.

When shaping canals, it should be appreciated that there are both advantages and disadvantages associated with utilizing continuous rotating versus a reciprocating movement.

The goal of this study was to evaluate apical debris extrusion after canal preparation with three rotary nickel-titanium (NiTi) rotary instruments, M-Pro, 2-Shape Files (Micro Mega) and ProTaper Universal (Dentsply) using 3 types of Irrigation Saline, Sodium Hypochlorite (2.5%) and MTAD (BioPure).

## AIM OF THE WORK

The present study was conducted to compare between the M-Pro, 2-Shape and ProTaper Universal Nickel Titanium (Ni-Ti) Rotary Files in terms of Apical Debris Extrusion.

## MATERIALS AND METHODS

### Materials:

***Rotary Files:*** M-Pro NiTi Rotary Files. 2-Shape NiTi Rotary Files. ProTaper Universal NiTi Rotary Files.

***Irrigants:*** Saline. Sodium Hypochlorite (2.5%). MTAD Irrigation (BioPure).

### Rotary files:

#### *ProTaper system:*

This system consists of one file as an orifice opener (SX), two shaping files (S1, S2) and five finishing files (F1-F5). File tips range in size from 002 to 005 with variable taper.

Shaping files and finishing files up to F2 were used in each canal following manufacturer's instructions.

#### *2-shape system:*

The 2-shape system consists of two instruments the TS1 and TS2 files with a tip size #25 and constant taper 004 and 006 respectively.

#### *M-Pro system:*

M pro system consists of 3 files system one opener file tip size #18 taper 009 and two sharping

TABLE (1): Sizes of ProTaper file system

| No. of instruments/set | Cross section | Tip sizers/ tapers | Length |
|---|---|---|---|
| 3 shaping files (SX,S1,S2) | Convex triangular | Sx(19/0.035) | 25mm |
| 2 finishing files (F1,F2) | | S1(17/0.02) | |
| | | S2(20/0.04) | |
| | | F1(20/0.07) | |
| | | F2 (25/0.08) | |

files tip sizes #20 taper 004 and #25 006. It has a convex triangular cross-section design with non-cutting guide tip design

## METHODS

### *Sample Selection*

Sixty three freshly extracted mandibular first molar teeth (anonymous teeth from an archive of extracted teeth at Endodontic Department, Faculty of Dentistry, Ain Shams University) were used for this study. Teeth were selected on the bases of mature apices and separate mesial canals with no noticeable defects or abnormal root morphology. The selected teeth were cleaned from soft tissue debris, blood and calculus using ultrasonic scaler and immersed for 15 minutes in 5.25% sodium hypochlorite solution to remove any soft tissues. Teeth were then stored in distilled water at room temperature till the time of use.

### *Classification of Samples*

The selected sixty three teeth were randomly classified into 3 main groups, according to the type of files used in canals preparation: **Group 1 (n=21);** Canals were cleaned and shaped using M-Pro Files. **Group 2 (n=21);** Canals were cleaned and shaped using 2-Shape files. **Group 3 (n=21);** Canals were cleaned and shaped using ProTaper Universal files (Control Group).

Each group was subdivided into three subgroups according to the type of the irrigation used: **Subgroup A (7 teeth)** Irrigation used was Saline. **Subgroup B (7 teeth)** Irrigation used was Sodium Hypochlorite solution (2.5%). **Subgroup C (7 teeth)** Irrigation used was MTAD.

### *Sample Preparation*

The root canal was negotiated with a size 10 stainless steel endodontic K file until visualized at the apical foramen. This length was recorded and the working length was established by subtracting

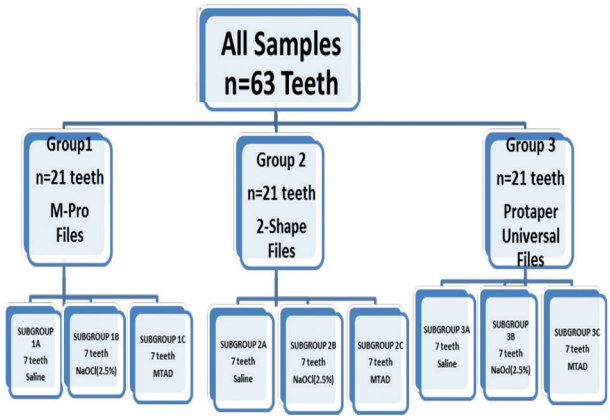


Fig. (1): Demonstrating Classification of samples:

1mm from the recorded length. Canals was irrigated with 5ml Saline (subgroup A), 5ml 2.5% NaOCl throughout instrumentation with a side-vented needle at working length (subgroup B) and 5ml MTAD (BioPure) (subgroup C). All canals were instrumented by crown-down technique to the working length to a final apical size of 35/.04.

### *Root canal instrumentation:*

Root canal instrumentation was performed in strict accordance with the manufacturer's recommendations for each system. All files were operated by a 20:1 gear reduction handpiece powered by an electric torque control motor ENDO-MATE. Canals were irrigated with 5ml Saline (subgroup A), 5ml 2.5% NaOCl throughout instrumentation with a side-vented needle at working length (subgroup B) and 5ml MTAD (BioPure) (subgroup C). Each canal was prepared to the working length in a crown-down sequence, and the final apical preparation was set to size 35 in each group at which:

Group 1: M-pro Files were used (orifice opener 18# .09 taper, 20# .04 taper, 25# .06 taper, 35# .02 taper Mani manual K-Files).

Group 2: 2-Shape Files were used (25# .04 taper, 25# .06 taper, 35# .02 taper Mani manual K-Files).

Group 3: Pro-Taper Files were used (Sx 19# .035 taper, S1 17# .02 taper, S2 20# .04, F1 20# .04

taper, F2 25# .08 taper, 35# .02 taper Mani manual K-files). NSK, Tokyo, Japan

***Evaluation:***

**Apical Debris Extrusion:**

The teeth were mounted first to pre-weighted tubes for collecting the apically extruded dentin. During the procedures of Chemico-mechanical canal preparations all apically extruded debris were collected in all sub-groups.

The tubes were leaved in an incubator at 70 $C^0$ for 5 days for complete desiccation before post-operative weighting to avoid weighting of irrigation remnants with the apically extruded dentin. The assessment of apically extruded debris was done quantitatively by weighting the tubes after collection of dentin debris using electronic analytic balance with accuracy for weighting of the vial empty and after collection of the apically extrude dentin inside it. The weight of the empty tube before chemico-mechanical preparation was subtracted from the weight of the tube after collection of apically extruded debris during the process and desiccation of the tube to eliminate the remnants of the irrigating solution to get the weight of the dry apically extruded dentin.

**Statistical analysis:**

Numerical data were explored for normality by checking the data distribution, calculating the mean and median values and using Kolmogorov-Smirnov and Shapiro-Wilk tests. Data showed parametric distribution so; it was represented by mean and standard deviation (SD) values. One-way ANOVA test followed by Tukey's post hoc test was used for different comparisons analysis. The significance level was set at $p \leq 0.05$ within all tests. Statistical analysis was performed with IBM® SPSS® Statistics Version 26 for Windows.

## RESULTS

TABLE (2): Mean ± standard deviation (SD) of dentine extrusion (mg) in different groups.

| File type | Dentine extrusion (mg) (mean±SD) | | | p-value |
|---|---|---|---|---|
| | Saline | Naocl | MTAD | |
| **M-Pro** | $5.29\pm1.60^{C}$ | $22.29\pm2.14^{A}$ | $13.86\pm1.57^{B}$ | **<0.001*** |
| **2-Shape** | $0.002\pm0.0009^{C}$ | $0.02\pm0.01^{A}$ | $0.01\pm0.01^{B}$ | **<0.001*** |
| **Protaper** | $0.20\pm0.08^{C}$ | $2.14\pm0.90^{A}$ | $0.67\pm0.18^{B}$ | **<0.001*** |

***Different superscript letters indicate a statistically significant difference within the same horizontal row *.***

TABLE (3): Mean ± standard deviation (SD) of dentine extrusion (mg) in different file types

| Irrigation material | Dentine extrusion (mg) (mean±SD) | | | p-value |
|---|---|---|---|---|
| | M-Pro | 2-Shape | Protaper | |
| **Saline** | $5.29\pm1.60^{A}$ | $0.002\pm0.001^{C}$ | $0.20\pm0.08^{B}$ | **<0.001*** |
| **Naocl** | $22.29\pm2.14^{A}$ | $0.02\pm0.01^{C}$ | $2.14\pm0.90^{B}$ | **<0.001*** |
| **MTAD** | $13.86\pm1.57^{A}$ | $0.01\pm0.01^{C}$ | $0.67\pm0.18^{B}$ | **<0.001*** |

***Different superscript letters indicate a statistically significant difference within the same horizontal row *.***

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## DISCUSSION

One of the most important objectives for root canal preparation is making proper shaping of the canal to create a continuously tapered funnel form which facilitates irrigation and obturation of root canals. However, during preparation, some root canal aberrations are created, such as transportation and apical zip. It has been shown that root canal instrumentation leads to changes in the working length by straightening of the canals during the course of treatment. [2]

Ni-Ti instruments had been introduced over decades with different designs and manufacturing methods in attempt to enhance their performance in root canal shaping. Three main phases of Ni-Ti alloy, defined as Austenite, Martensite and R-phase have been advocated to use their special properties, such as superelasticity of Austenite and shape memory of Martensite, in order to improve the performance of different Ni-Ti files.

The choice of the instruments compared in the current study was not accidental. The three file systems were selected as they have different geometrical designs, and way of manufacturing.

2-Shape is a sequence with two shaping files in continuous rotation which have been heat-treated by using the T•Wire technology. The instruments' flexibility provides user comfort and an outstanding negotiation of curvatures. The instruments return to their initial shape after each use. It is claimed to have increased resistance to cyclic fatigue (+40%) and a better negotiation of canals. It's a 2-file system (TS1 and TS2) which claimed to return to their original shape after use. With asymmetrical cross-section with triple helix two primary cutting edges and one secondary cutting edge aids in debris removal and increasing cutting efficiency. [3]

While, the selection of M- Pro Nickel Titanium rotary system, was because the fact that it was recently introduced into the market and there were no data available on its behavior in the root canal. Thus, we needed to shed a light on it's shaping and cleaning ability. It is 3-file system (orifice opener and two shapers) made of x-wire alloy, which is a modification of CM-wire alloy that has increased strength and better flexibility. It's claimed to be prebendable decreasing screw in effect and reducing fracture risk. The files have convex triangular cross section with three cutting edges and non-cutting tip which claimed to increase cutting efficiency and reducing risk of apical transportation. [4]

The ProTaper is a file used in rotational motion. It's convex triangular cross-section enhances cutting action while decreasing rotational friction between the blade of the file and dentin. The non-cutting tip design allows each instrument to safely follow the secured portion of the canal while the small flat area on the tip enhances its ability to find its way through soft tissue and debris.[5]

The studies claimed that the continuous rotation improved coronal transportation of dentin chips and debris by acting like a screw conveyer.

The irrigant used during the chemo-mechanical preparation was 2.5% Sodium Hypochlorite (NaOCl), MTAD, saline. But NaOCl is the most commonly used concentration in routine endodontic practice. Clinically, this concentration was chosen to achieve a balance between the antibacterial activity and cytotoxicity. [8]

Outcomes were assessed at three levels; 3, 5, and 7 mm from the root apex to represent the canal's apical, middle and coronal thirds.[9]

The assessment of apical extrusion of debris showed significant difference with either saline, MTAD or sodium hypochlorite irrigation where the rotational M-pro file showed more apically extruded dentin than either the rotational ProTaper file or 2-shape file systems.

These results showed a significant difference between the three files at which more extrusion of debris with M Pro files than ProTaper than 2-shape files. This was in agreement with results of **Girgis et al[10], Hamdy et al[11], Abdullah et al[12], Abd El Hamid et al[13], Gunes at al[14], Kalra et al[15], Leski et al[16].**

These results might be due to the viscosity of MTAD which is higher than hypochlorite. This may cause entrapment of the dentin debris inside the canal and prevent its extrusion from the apex and the great taper of M Pro files (25# .06 taper) with it's rotational movement so it touch all the canal walls with a great dentine removal.

**Bordagaray et al[17], Saricam et al[18], Kasikci et al[19], Maia et al[20],** results were against the results of this study, where they found that there was no significant difference in debris extrusion between these files.

The extruded debris collected was not significantly different (P>0.05).

## CONCLUSION

In view of the results of the present study, the following conclusions can be drawn: Highest debris extrusion produced with using M-pro files with using NaOCl. Lowest debris extrusion produced with using 2shape files with using Saline.

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