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Comparative Evaluation of Three Different Rotary NiTi File System with Different Generation for Root Canal Centric Ability Using CBCT: An *in-vitro* Study

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Abstract: ***Introduction*: Successful root canal treatment depends on the removal of micro-organisms through instrumentation of the root canal system. This encompasses shaping by mechanical removal of the dentine and cleaning by chemical disinfection of microorganisms and dissolution of organic tissues from the root canal. While root canal shaping can be predictably and efficiently attained with advanced instrumentation technology, effective cleaning of the entire root canal system remains a challenge. Rotary Ni-Ti instruments are known for their efficient preparation of root canal. This is because of the super elasticity of the nickel titanium alloy which gives an increased flexibility and allows the instrument to efficiently follow the original path of root canal. The aim of this study is to compare the cleaning efficiency and shaping ability of Pro Taper Next, Mani Silk and M Two rotary instruments during the preparation of curve canals in extracted molars. *Materials and Methods*: Thirty teeth with 12 mm as their working length were selected and divided into three groups of 10 teeth each Angle of curvature, Radius of curvature, was determined using computerized tomography. A Pre and Post-operative measurement of canal width and volume was recorded and compared using CB-CT. *Results*: Results were calculated and statistically analysed to evaluate the shaping ability and cleaning efficiency. *Conclusion*: The study concluded that ProTaperNext rotary system has negligible canal transportation and better centric ability in compression to Mani Silk and M tow rotary file system. It is one of the few rotary systems that provides quick and safe endodontic preparation.***

Keywords: Cleaning and shaping, Computerized tomography, Pro Taper Next, Mani Silk and M Two

1. Introduction

Over the decades, a staggering array of files have emerged for negotiating and shaping them. In spite of the design of the file, the number of instruments required and the surprising multitude of techniques advocated, endodontic treatment has typically been approached with optimism for probable success.

Since the beginningof modern-day endodontics, there have been numerous concepts, strategies, and techniques for preparing canals. Objective in root canal preparation is to develop a shape that tapers from apical to coronal, maintaining the original canal shape.

During cleaning and shaping of curved root canals, several procedural errors can occur. Such iatrogenic accidents include apical transportation, zips, ledges, root perforations, loss of working length or straightening of root canals. When a curved root canal is enlarged, the use of progressively greater files decreases the angle of curvature, owing to the tendency to move towards the outer wall of the root canal, for which reason a non-instrumented inner dentine wall in the apical third may entail a worse prognosis for treatment.

The fifth generation NiTi rotary system have been designed in such a way that the centre of mass or the centre of rotation, or both, are offset. When in rotation, files that have an offset design produce a mechanical wave of motion that travels along the active length of the file. In addition, it enhances the removal of debris from a canal and improves flexibility along the active portion of the file.

In order to investigate the efficacy of instruments and techniques developed for root canal preparation, numerous methods have been used to evaluate the canal shape before and after instrumentation. Cone-beam computed tomography (CBCT) imaging is a non-invasive technique for analysis of canal geometry and efficiency of shaping techniques. Using CBCT it becomes possible to compare the anatomic structure of root canal before and after root canal preparation.

Hence the present study was conducted to compare the centric ability of three different fifth generation rotary NiTi file system i.eProtaper Next Densply, Silk from Mani & M TWO from VDW in curved root canal and also to evaluate which system do less canal transportation in curved canals.

2. Materials and Method

30 root canal of extracted human permanent mandibular 1st and 2nd molar teeth with various degree of curvature were taken from the department of oral and maxillofacial surgery.

Inclusion Criteria

- Posterior teeth
- Curved canals (“zero” to 40◦ of curvature)
- Mature root apex

- Extraction due to compromised periodontal condition

Exclusion Criteria

- Curvature above 40°
- Fractured teeth
- Immature apices
- Root resorption

Thirty mandibular molars extracted were stored. Canalcurvature angles of the teeth were measured according to Schneider (fig A). The crown of each tooth was removed at the level of the cementum enamel junction using a diamond disc to obtain a mesio-buccal root canal measuring 12 mm in length.

Access cavities were prepared by using diamond burs. A glide path was performed via a size 15 K-type file (DentsplyMaillefer, Ballaigues, Switzerland). RC Help (Prime Dental Products Pvt. Ltd.) was used in all canal preparations and the root canal was irrigated with 2 ml 2.5% sodiumhypochlorite solution after change of each instrument.

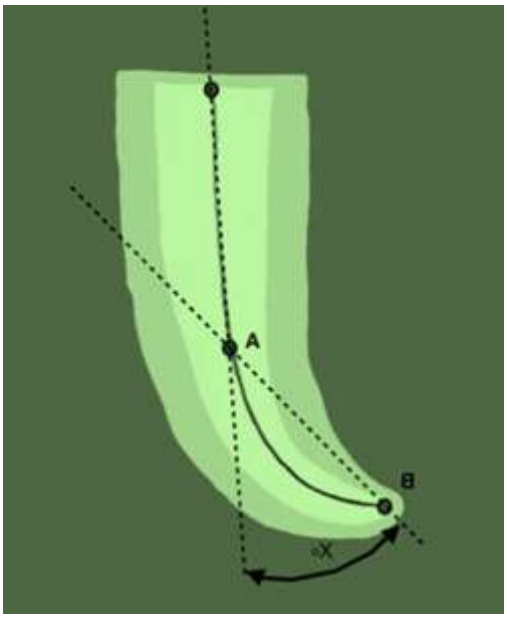


Figure A: A line is scribed on the radiograph parallel to the long axis of the canal. A second line was drawn from the apical foramen (Point B) to intersect with the first at the point where the canal begins to level the long axis of the tooth (Point A). These two lines intersect at an angle (X) as a measure of the change in direction of the canal in relation to the long axis of the tooth. NPRE

Marked Canal Orifices for the Preparation

These 30 teeth were divided into three groups after initial bio-mechanical preparation till 20# K-file and 3% of sodium hypochlorite:

- GROUP 1- Canal prepared using ProTaperNext Densply file system
- GROUP 2- Canal prepared using Mani Silk file system
- GROUP 3- Canal prepared using M TWO VDW file system

The preparation sequences were as follows:

In Group 1: ProTaper Next files were used with the sequence ProTaper Universal SX, PTN X1, and X2 at a rotational speed of 300 rpm along with torque values of 200 g/cm. Each file was used with a brushing motion similar to the PU files.

In Group 2: Mani Silk 0.08/25 (OO) the cervical dentinal triangle (CDT) is removed and the orifice is shaped. After orifice shaping the 0.04/20 is inserted to resistance followed by the 0.04/25 Silk. The sequence is repeated until the 0.04/25 reaches the True Working Length. 500 rpm is recommended for all Silk instruments with a torque setting of 300 g-cm.

In Group 3: The 3 file M TWO rotary system , 10/.04 ,15/.05 ,20/.06 & 25/.06 files sequence used. All files should reach to the apex in brushing motion.

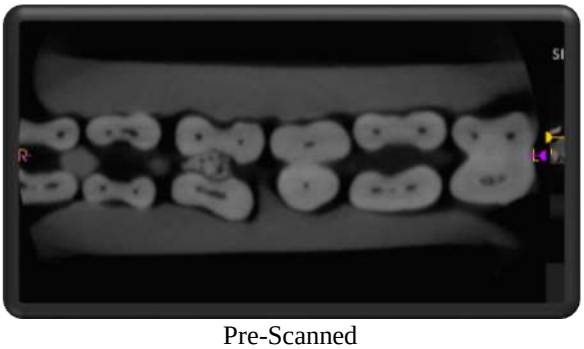
After canal shaping, post-instrumentation CBCT scans were performed with similar values and position as pre-instrumentation scans.

Transportation at each level was calculated using the following formula:

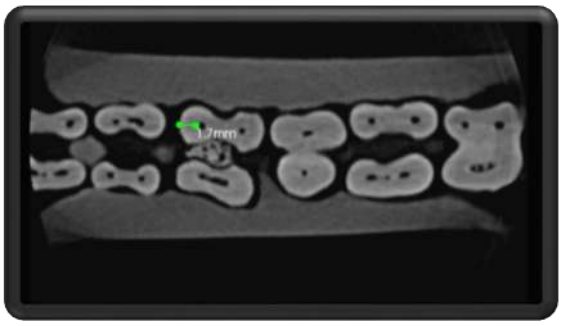
$$(X1-X)-(Y1-Y2)$$

The canal centering ratio at each level was calculated using the following formula:

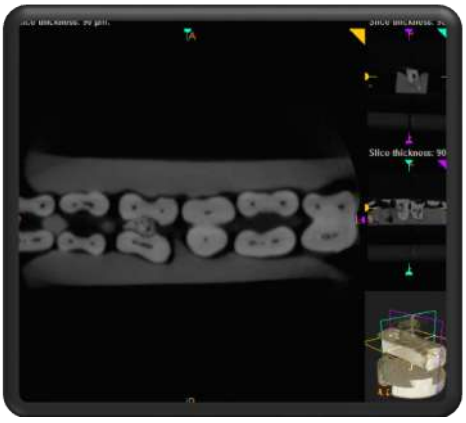
$$(X1-X2)/(Y1-Y2) \text{ or } (Y1-Y2)/(X1-X2)$$



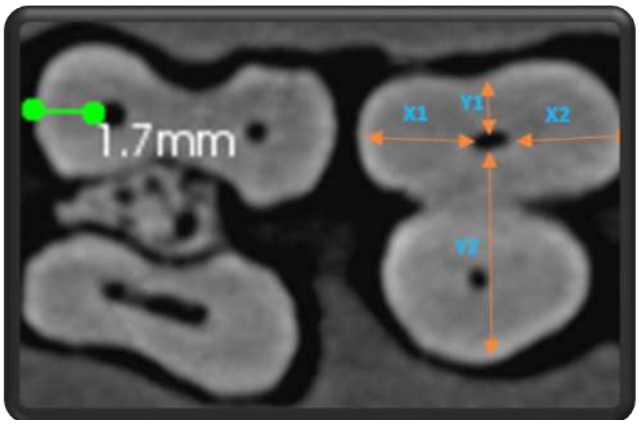
Pre-Scanned



Post-Scanned



Pre-Preparation



Post-Preparation

Changes in canal transportation and centering ratio data were analyzed using the Kruskal–Wallis ANOVA which showed statistical significant difference and pairwise comparison was done by Mann–Whitney *U*-test. The significance level was set at $P = 0.05$. Statistical analysis was performed with SPSS statistics version.

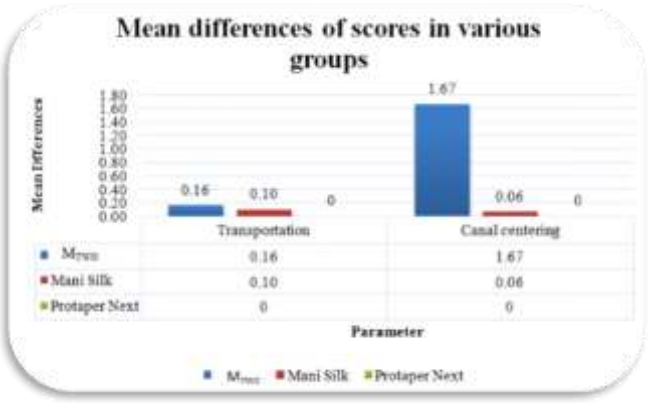
3. Result

Table 1 shows transportation and canal centering of curved canals.

No files fractured during the study. The ProTaper Next showed least canal transportation and better centering ability as compared to Silk Mani and M TWO. In pair wise comparison M TWO – ProTaper Next combination is highly significant.

Table 1: Canal Transportation and centric ability of curved canals

Groups	Transportation		Canal centering	
	Mean	SD	Mean	SD
M TWO	0.16	0.09	1.67	2.56
Mani	0.10	0.14	0.06	0.14
Protaper Next	0	0	0	0
H value	5.307		9.647	
p value	0.070		0.008**	
Pair wise comparison by man whitney U test				
M TWO - Mani	0.548		0.056	
M TWO - Protaper Next	0.032*		0.008**	
Mani - Protaper Next	0.31		0.69	



Graph 1: Graphical comparison of three groups

4. Discussion

Maintenance of the original root canal shape is an important goal in root canal preparation and fundamental aspect of endodontic therapy. The purpose of mechanical instrumentation is to remove the infected soft and hard tissue from the root canal and to create a sufficient taper for the subsequent placement of root filling materials.

As the rotary NiTi instruments maintained the original canal curvature, studies compared the shaping ability of different rotary NiTi systems with different designs.

In this study, an evaluation on the effects of three newly developed file systems belonging to the fifth generation that have different cutting blade designs, metallurgies, manufacturing process along with sequence and number of files on the parameters of canal transportation and centering ratio by using CBCT imaging was performed. Schneider´s method has been used extensively in the quantification of root canal curvatures. The curvatures of root canals ranged between zero° and 40°.

Computed tomography allow a noninvasive and reproducible three dimensional evaluation of external and internal morphology of the tooth. Therefore we used CBCT in this study as it leads to increased precision, resolution and the time of exposure of radiation.

ProTaper Next consists of five files (X1, X2, X3, X4 and X5) with color coded identification ring of yellow, red, blue, double black, and double yellow on their handles respectively. PTN files were used in sequence:

PU SX followed by X1 (17/0.04), X2 (25/0.06). The X1 and X2 are the shaping and finishing files and X3, X4 and X5 are optional.

ProTaper Next (PTN) is a NiTi file system; which has three significant design features, including

- Progressive percentage tapers on a single file,
- M-wire technology,
- And different offset mass of rotation

This rotary file system utilizes both an increasing and decreasing percentage tapered design on a single file. This design feature serves to minimize the contact between a file and dentin, which reduces dangerous taper lock and the screw effect while increasing efficiency. Incorporating M-Wire into the mechanical design of ProTaper Next (PTN) improves the resistance to cyclic fatigue, decreases the potential for broken instruments, and increase flexibility. PTN files produce a unique asymmetrical rotary motion and, at any given cross-section, the file only contacts the wall at 2 points.

Silk's Mani unique cross sectional tear drop design cuts exceptionally well and resists fracture, which eliminates the "screwing-in" effect common with many other systems while removing debris efficiently and reducing instrument stress. Silk instruments are also available (three files per pack) in the following individual sizes: 0.04/20, 0.04/25, 0.04/30, 0.04/35, 0.04/40, 0.06/20, 0.06/25, 0.06/30, 0.06/35, 0.06/40 and 0.08/25. All pack configurations and individual sizes are available in 21 and 25 mm. After orifice shaping the 0.04/20 is inserted to resistance followed by the 0.04/25 Silk. The sequence is repeated until the 0.04/25 reaches the True Working Length.

M TWO has S-shaped cross-section with two active cutting edges and Small instrument core for high flexibility while being safe and resistant to fracture. the file has Active cutting blades and a progressive pitch which allows efficient dentine removal and lateral cutting. The 3 file M TWO rotary system:Glide-Path. M two for basic Sequence : 10/.04 ,15/.05 ,20/.06 & 25/.06. Shaping of Larger Canal Anatomies : 30/.06, 35/.06, 40/.06 & 25/.07.

There are many studies in the literature showing the shaping ability of single-file systems and conventional ones using a full range of instruments. There is hardly any study which compared M TWO file system.

5. Conclusion

The study concluded that ProTaperNext (DentsplyMaillefer, Ballaigues, Switzerland) rotary system has negligible canal transportation and better centric ability in compression to Mani and M tow rotary file system. It is one of the few rotary systems that provides quick and safe endodontic preparation.

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