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A Comparative Study to Evaluate Canal Transportation and Centering ability of Simulated Curved Canals Prepared by XP-Shaper,WaveOne Gold and ProTaper NEXT Files

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Abstract

Aim: The objectives of this study are to compare and evaluate under standardized experimental conditions the centering ability (centering ratio) and canal transportation (outer and inner transportations) of three NiTi instruments ProtaperNext files (Dentsply Maillefer),, XP-endo shaper (XP; FKG Dentaire, La Chaux-de-Fonds, Switzerland), Waveone Gold files (PTG; Dentsply Tulsa Dental Specialties), in simulated curved canals of 40° curvature at different levels.

Methods: 60 Readymade simulated curved canals made of clear polyester resin (DENTSPLY Maillefer ,Ballaigues,Switzerland) will be used in this study were randomly assigned to 3 experimental groups (n = 20). In the Waveone Gold and PTN the first preparation in the simulated canals will perform with # 10 K-file to full working length (16mm) while for XP-Shaper canals will perform with # 15 K-file. Prior to their preparation, each simulated canal will fill with a drawing ink using a 27 gauge needle to enhance photographic contrast. Photographs of prepared and unprepared canals will be taken by the aid of stereomicroscope and digital camera at magnification of 40 times.

Results: the XP Shaper system that preserved the best rate of shaping among the inner/outer walls over the total length of the simulated curved canals (i.e. values closest to 0) than that of the ProTaper NEXT and WaveOne Gold instruments.

Conclusion: The XP-shaper group showed less canal transportation and better centering ability than ProTaper Next and WaveOne Gold groups at all the five measuring levels, The WaveOne Gold group showed less outer canal transportation at the beginning and the apex of the curve, and better centering ability than ProTaper Next group at all the five measuring levels, ProTaper Next group showed less inner transportation at the end of preparation, while WaveOne Gold is better in the middle part (half – way levels & beginning of the curve) & the least centering ability at all the five measuring levels.

Key Words: canal transportation, centering ability, nickel-titanium instrument

Introduction

There have been major improvements in the treatment of nickel titanium (NiTi) instruments, such as electro-polishing, electro-

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discharge machining, and thermal treatment protocols that provide rotary instruments with more flexibility (**12).** Many manufacturers have incorporated different designs into their NiTi systems in order to minimize apical transportation and to achieve faster and more predictable canal preparation **(7).**

The XP Shaper (FKG, La Chaux-de-Fonds, Switzerland) is a recently introduced endodontic rotary instrument. It is manufactured from a MaxWire alloy and has a tip size of ISO #30 with a 0.01 taper across the length of the instrument. The manufacturer claims that the instrument can expand from its original size to enlarge the canal to at least 30/04 while addressing the 3-dimensional structure of the root canal space. They also claim that the booster tip of the instrument enables the file to enlarge the canal from an apical size of #15 to #30 in a single step without the need of the traditional incremental increase in apical size **(4).**

The WaveOne Gold (Dentsply Tulsa Dental Specialties) system is a single-file and single-use technique. Through the convergence of an advanced design, Gold-wire technology, and a unique reciprocating movement, preparing canals is safer, easier and faster than with WaveOne (at least 80% more flexible, 50% more resistant to cyclic fatigue, and 23% more efficient, compared to the original Primary WaveOne M-wire file). Each file has a fixed taper from D1-D3, yet a progressively decreasing percentage tapered design from D4-D16, which serves to preserve dentin **(10).**

ProTaper Next (PTN; Dentsply Maillefer, Ballaigues, Switzerland) is a relatively new system. PTN instruments are made of M-wire, a unique NiTi alloy manufactured by a thermal treatment process that reportedly increases flexibility and resistance to cyclic fatigue (**14)**. These instruments incorporate a variable regressive taper design, unique offset mass of rotation, and rectangular cross section, which according to the manufacturer are designed to reduce points of contact with the canal walls generating less fatigue in the instrument during use (**2).**

Material & Methods

Sixty Readymade simulated curved canals made of clear polyester resin (Endo-Training Block .02 taper, Dentsply, Maillefer, Switzerland) were used in this study to assess the instrumentation. The diameter and taper of all simulated canals were equivalent to an ISO standard size 10 root canal instrument.

The eighty canals were 15 mm long (from the beginning of the funnel), the straight part being 10mm and the curved part 5 mm.

Preparation of artificial canals:

The first preparations in the simulated canals were performed with # 10 K-file to full working length (15 mm); except for xp-endo shaper the canal prepared to size #15 K-file. Patency of the resin blocks was checked with the same file before preparation and confirmed after each sequence. The 60 canals were divided into three groups of 20 blocks. Prior to their preparation, each simulated canal was filled with a drawing ink for enhancing the color contrast of the images Before and after instrumented canal shapes were taken in a standardized manner and magnified 40 times by means of a stereomicroscope and photographed by using a digital camera that fixed above the eye's lens of the microscope and stored in a computer (Pentium 4) as pre- and postoperative image **(1).**

Prior to instrumentation, each file was dipped in a glycerin that act as a lubricant, and Approximately 5 ml of distilled water was used per canal for copious irrigation that performed repeatedly before and after the use of each instrument **(11).**

Assessment of canal preparation:

When the instrumentation of the canal was completed, the image procedure was repeated, a composite image was produced of pre- and post-instrumentation images and superimposed by using Adobe Photoshop CS6 software program, and the measurements were made at five reference points, using a method described by **Calberson et al.** in **2002**.

By the aid Adobe Photoshop CS6 software program, the central line of the canal was drawn With the aid of AutoCAD 2016 software program, the distance between central line and the edge of the preoperative canal was measured on the inner curve (concave side) X1, and on the outer curve (convex side)Y1. Also the distance between central line and the edge of the post-operative canal was measured on the inner curve (concave side) X2, and on the outer curve (convex side) Y2.

The ratio of difference of the measurements of the concave and the convex parts of post-operative canal was compare with the width of filed canal (X2+Y2) **(5)**

Statistical Analyses:

The difference among groups was examined by(IBM SPSS Version 20) ANOVA (analysis variance of mean), least significant difference (LSD) to test any significant difference between each two groups or levels within the same group.

Results

The Protaper Next and WaveOne Gold instruments show no statistically significant difference between them at the first level, while the difference is significant at level 3&5 & highly significant difference between them at level 2 and 4. While the relation between ProTaper Next and Xp-endo shaper was highly significant at all measuring levels. Also the relation between, WaveOne Gold and Xp-endo shaper was significantly different at levels 1, 2, 4 ,5, except at level 3 it was highly significant difference.

Discussion

Transportation of the canal is affected by the flexibility of the preparation instruments, the movement of the instruments in the canal, as well as the length time the instruments is in contact with the canal wall during preparation **(9).**

The direction of transportation of rotary NiTi instruments observed in this study was generally toward the inner aspect at middle parts of the canal and toward the outer aspect of the curve at the apex of curve and the end of preparation. This is mainly due to the restoring forces of the metal where the forces in straight file in a curved canal attempt to return the file to its original shape and straighten it toward the outer curvature thereby preferentially removing material in this area during preparation and thus, lessens its cutting along the inner wall **(3).**

The findings of this study displayed that all of the three systems showed a trend to straighten the canals; yet it was the XP-Shaper system who preserved the best rate of shaping among the inner/outer walls over the total length of the simulated curved canal than that of ProTaperNext and WaveOne Gold instruments but; unfortunately, the results with the system XP-Shaper cannot be compared with others because currently similar studies are not available, these observations could be related to several reasons: the XP-Shaper manufacture from MaxWire alloy, that characterized by super elasticity and shape memory **(6),** could be attributed to the difference in taper of the last instrument used for the preparation, Its small mass and expanding type of movement **(4),** XP Shaper design the booster tip lead section fits into the pre-established glide path ensuring precise guidance and centering of the instrument **(8),** shorter time of preparation with XP-Shaper, as the length of time the instruments is in contact with the canal wall during preparation decrease the transportation will also decrease (9).

In this study, WaveOne GOLD showed less outer transportation at the beginning and the apex of the curve. This could be probably attributed to the metallurgic alloy and greater flexibility of the WOG instruments might explain this as compared to M-Wire.

In regard of inner transportation, there was superiority of PTN at the end of preparation, while WaveOne Gold is better in the middle part (half – way levels & beginning of the curve) this in agreement with other recent study Ginjeira et al., 2016.

While regarding centering ability in this study the WaveOne Gold instruments came in the second order after XP Shaper instruments regarding centering ratio. The WaveOne Gold showed a better centering ability when compared with PTN at all the five measuring levels & this may be due to several reason, the new super metal **(11),** the reverse helix design that enable a file to more readily advance without using excessive inward pressure **(13)**, the different taper that the systems have between each other.

By comparing the time of preparation among the groups the XP Shaper was significantly faster than WaveOne Gold and ProTaper NEXT to completely shape the canal by almost 2 minute. Although the actual instrumentation time in both remaining groups was close, more time was required to completely shape the canals in the ProTaper Next group because of the need to irrigate more frequently between files to remove debris and facilitate the insertion of the subsequent file.

The conclusion drawn from this study can be summarized as the following:

1. The XP-shaper group showed less canal transportation and better centering ability than ProTaper Next and WaveOne Gold groups at all the five measuring levels.
2. The WaveOne Gold group showed less outer canal transportation at the beginning and the apex of the curve, and better centering ability than ProTaper Next group at all the five measuring levels.
3. ProTaper Next group showed less inner transportation at the end of preparation, while WaveOne Gold is better in the middle part (half – way levels & beginning of the curve) & the least centering ability at all the five measuring levels.

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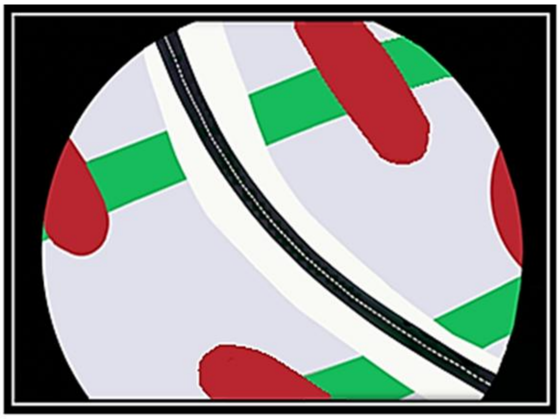

Figure (1) the super imposed and treated images of unprepared and prepared canal with computerized program Adobe Photoshop

Figure (2): Some of the materials and equipment used in this study

Figure (3): Imaging the resin blocks with standardized position of stereomicroscope and digital camera.

Table (1-1): LSD test results of centering ratio (μm) after instrumentation at five levels comparing the tested groups

Levels	Groups		Mean Difference	p-value	Sig.
O	1	2	0.77900	0.762	NS*
		3	7.49450*	**0.005**	**HS***
	2	3	6.71550*	0.011	S*
OH	1	2	8.90600*	**0.001**	**HS**
		3	14.87800*	**0.000**	**HS**
	2	3	5.97200*	0.026	S
BC	1	2	6.94600*	0.032	S
		3	23.04700*	**0.000**	**HS**
	2	3	16.10100*	**0.000**	**HS**
AC	1	2	11.37200*	**0.001**	**HS**
		3	18.67800*	**0.000**	**HS**
	2	3	7.30600*	0.030	S
EP	1	2	8.91750*	0.042	S
		3	20.02700*	**0.000**	**HS**
	2	3	11.10950*	0.012	S

*NS P> 0.05 *S P ≤ 0.05 * HS P< 0.01