

Comparison of rotary NiTi reciprocating file systems using Cone Beam Computed Tomography in root canal transportation

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ABSTRACT

Aim: To assess the root canal transportation caused by these rotary NiTi reciprocating file systems using 3D cone beam computed tomography

Method: This experimental study was conducted on 60 samples of rotary NiTi reciprocating file systems using CBCT. The extent of canal transportation and the centering ratio was analyzed using independent sample t test. The significance level was set at 95%.

Results: Mean apical canal transportation was lower in wave one Gold groups as compared to Reciproc (0.8724±0.04SD vs 0.9463±0.02SD, p=0.000). Mean apical canal transportation at 5 mm was lower in wave one gold group as compared to reciproc blue group (0.5610±0.02SD vs 0.7253±0.06SD, p=0.000). Mean apical canal transportation at 8mm was lower in wave one group as compared to reciproc blue (0.358±0.03SD vs 0.5766±0.10SD, p=0.000).

Conclusion: Wave one Gold had high centering ability and lower canal transportation as compared to Reciproc Blue single file system. CBCT is an efficient method of understanding Canal transportation

Keywords: CBCT, NiTi wire, Root canal transportation, Reciproc blue

INTRODUCTION

Shaping of a canal is quite critical step while treating a patient endodontically as this step affects the results of the following stages such as canal irrigation, filling, and the finally defines the treatment success. Several instruments as well as irrigating materials are used in the treatment of root canal to shape the canal properly and prepare it at chemo-mechanical level which later on receive a 3D filling in the prepared hollow root canal cavity.¹ The introduction of instruments is to develop a constantly tapered preparation that preserves the anatomy of canal, conserving the foramen as minor as it could be without any deviance from the unique curvature of canal.² The rotary NiTi reciprocating file systems are used for maintaining the canal anatomy in root canal therapy. This rotary NiTi reciprocating file systems are of different thickness and the most appropriate thickness of rotary NiTi reciprocating file system has to be explored using latest radiographical technique CBCT.

Preparation of canal during root canal therapy results in eccentricity of the anatomy of canal causing canal transportation which later on causes poor root canal treatment outcomes. Using Cone Beam Computed Tomography (CBCT), the anatomy of the root canal was observed before and after the canal preparation which revealed that no significant difference was found using Reciproc and One Shape during canal preparation in terms of canal transportation.³ Thickness of dentin was least reduced by Protaper as compared to Mtwo and WaveOne which showed higher level of reduction in the thickness of dentin which was not statistically significantly different. But

after the biomechanical preparation of canal, WaveOne is the most frequently used rotary endodontic instrument⁴.

There are many factors associated with the successful root canal therapy but the most important is the canal preparation as maintaining the anatomy of canal is important, otherwise leads to canal transportation. The difference in cross-sectional area after the filling revealed a significant difference at 0mm, 1mm, 2mm and 7mm. Using three different rotary instruments, i.e., wave one and oneshape and reciproc at 0mm, 1mm, 2mm and 7mm, difference was explored in terms of canal transportation which revealed a significant difference at various lengths. It was concluded that reciprocating motion is better than rotary motion in all the three parameters Canal Transportation, Cross-sectional Area, Cervical Dentinal Thickness.⁵ Comparison of One Shape, Rotary ProTaper, and Wave One systems in terms of canal transportation was made using CBCT in root with curved canals proposed that Wave One files offered the superlative results. Less canal transportation was caused by Wave One files.⁶ After the WaveOne primary reciprocating files and nickel-titanium (NiTi) rotary ProTaper instrumentation, the curvature of canal and axis modification was done which revealed that instrument factor was enormously important for both the CRr parameter and the rAe parameter. On using new WaveOne NiTi single-file system, reduction in canal modifications was observed.⁷

But reciprocating single file systems are the latest innovation in Endodontics, with claims of superior strength, increased fracture resistance and ease of use. This study was designed to assess the root canal transportation caused by these rotary NiTi reciprocating file systems using 3D cone beam computed tomography

Received on 12-02-2021

Accepted on 28-05-2021

MATERIAL AND METHODS

This in-vitro experimental study was conducted at The University College of Dentistry, University of Lahore using 60 human extracted mandibular molar teeth using formula

Inclusion Criteria

- Mandibular first molars with Root that have completely formed apices
- length between 20-25mm from crown portion till apex
- Root canal curvature of 25 to 35 degrees

Exclusion Criteria

- Mandibular first Molars having developmental defects,
- Mandibular first molars with severely calcified canals,
- Mandibular first molars with Caries in the mesial root,
- Mandibular first molars with cracks, micro-cracks and fractures,
- Mandibular first molars undergone previous root canal treatment
- Mandibular first molars with open apices

Sample collection: After taking permission from the ethical review committee of the University of Lahore, sample of extracted human mandibular first molars was collected from the Oral and Maxillofacial surgery department. Extraction of mandibular molars was from either quadrants.

Sample Preparation: The teeth were embedded into transparent acrylic and randomly divided into 2 groups (N=30).The Teeth were accessed using a No 2 Carbide bur in a high speed handpiece with water spray. The mesio-buccal canal orifices were located and the canals were scouted using a size 10 K-file. The working length determination was performed under magnification by inserting a 10 K-file to the apex and subtracting 1mm from that measurement. The teeth in each group were prepared to length according to the manufacturers recommendation .The irrigation solution used was 3% NaOCl and EDTA gel was used as a lubricant.

Scanning protocol: The teeth were numbered and marked. The teeth were scanned before and after instrumentation using a CBCT device (Planmeca Promax 3D max, Finland) to evaluate the centering ability as well as the root canal transportation resulting from the two file systems. The scans were made at 84Kvp and 12mA at a resolution of 0.100mm³ voxel size.

Evaluation of Transportation: 3 cross sectional planes were used which were 2,5 and 8mm from the root apex .it is calculated based on the formula $(a_1 - a_2) - (b_1 - b_2)$. where a was the smallest measurement from the mesial extension of the un-instrumented canal to the mesial extension of the root and a_2 is the same dimension but measured after instrumentation. And b_1 is the value given to the smallest measurement from the distal extension of the root to the distal extension of the un-instrumented canal and b_2 is the same dimension but measured after instrumentation .This was done by 2 different observers and the average values were obtained. The transportation was calculated based on the method described in the study by Gambill et al¹³.According to this method, a number other than 0 indicates canal transportation

Data analysis: The extent of canal transportation and the centering ratio was analyzed using independent sample t

test. The significance level was set at 95%. All the statistical analysis was done using the SPSS 23.0

RESULTS

Total 60 samples were taken in study. Mean canal transportation at 2mm was 0.9038±0.52SD (apical), 0.7448±0.13SD (middle) and 0.7018±0.12SD (Coronal). Mean canal transportation at 5mm was 0.6431±0.09SD (Apical), 0.5783±0.12SD (Middle) and 0.5042±0.97SD (Coronal). Mean canal transportation at 8mm was 0.4673±0.13SD (Apical), 0.2998±0.05SD (Middle) and 0.2626±0.13SD (Coronal).

Table 1: Descriptive Characteristics (n=60)

| Descriptive characteristics | Mean | St. deviation | (Min-Max) |
|-----------------------------|--------|---------------|-----------|
| Canal transportation | | | |
| At 2mm | | | |
| Apical | 0.9038 | 0.52 | 0.78-0.99 |
| Middle | 0.7448 | 0.13 | 0.33-0.93 |
| Coronal | 0.7018 | 0.12 | 0.52-0.89 |
| At 5mm | | | |
| Apical | 0.6431 | 0.096 | 0.52-0.87 |
| Middle | 0.5783 | 0.120 | 0.41-0.87 |
| Coronal | 0.5042 | 0.97 | 0.41-0.87 |
| At 8mm | | | |
| Apical | 0.4673 | 0.134 | 0.32-0.87 |
| Middle | 0.2998 | 0.05 | 0.21-0.39 |
| Coronal | 0.2626 | 0.13 | 0.11-0.58 |

There were 30(50%) sample in wave one Gold group and 30(50%) sample were in Reciproc blue group. Mean apical canal transportation was lower in wave one Gold groups as compare to Reciproc (0.8724±0.04SD vs 0.9463±0.02SD, p=0.000). Mean middle canal transportation at 2mm was lower in waveone Gold as compare to Reciproc blue (0.65067±0.11 vs 0.8390±0.05SD, p=0.000). Mean coronal canal transportation was lower in waveone gold group as compare to Reciproc Blue (0.597±0.07 vs 0.8066±0.05SD, p=0.000).

Table 2: Comparison of apical Canal transportation, middle canal transportation, and coronal canal transportation at 2mm in both groups (n=60)

| Interventional groups | n | Apical Canal transportation at 2 mm | | P value |
|---|----|-------------------------------------|---------------|---------|
| | | Mean | St. deviation | |
| Wave one Gold | 30 | 0.8724 | 0.04 | 0.000 |
| Reciproc Blue | 30 | 0.9463 | 0.02 | |
| Middle Canal transportation at 2 mm | | | | |
| Wave one Gold | 30 | 0.65067 | 0.117 | 0.000 |
| Reciproc Blue | 30 | 0.8390 | 0.05 | |
| Coronal Canal transportation at 2 mm | | | | |
| Wave one Gold | 30 | 0.5970 | 0.07 | 0.000 |
| Reciproc Blue | 30 | 0.8066 | 0.05 | |

Mean apical canal transportation at 5mm was lower in wave one gold group as compare to reciproc blue group (0.5610±0.02SD vs 0.7253±0.06SD, p=0.000). Mean middle canal transportation at 5mm was lower in wave one gold as compare to Reciproc blue (0.472±0.04SD vs 0.6846±0.06SD, p=0.000). Mean coronal canal transportation at 5 mm was lower in wave one gold group as compare to reciproc blue group (0.4753±0.04 vs 0.581±0.07SD, p=0.000).

Table 3: Comparison of apical canal transportation, middle canal transportation and coronal canal transportation at 5mm in both groups (n=60)

| Interventional groups | n | Apical Canal transportation at 5 mm | | P value |
|---|----|-------------------------------------|---------------|---------|
| | | Mean | St. deviation | |
| Wave one Gold | 30 | 0.5610 | 0.02 | 0.000 |
| Reciproc Blue | 30 | 0.7253 | 0.06 | |
| Middle Canal transportation at 5 mm | | | | |
| Wave one Gold | 30 | 0.4720 | 0.04 | 0.000 |
| Reciproc Blue | 30 | 0.6846 | 0.06 | |
| Coronal Canal transportation at 5 mm | | | | |
| Wave one Gold | 30 | 0.4753 | 0.04 | 0.000 |
| Reciproc Blue | 30 | 0.5810 | 0.07 | |

Mean apical canal transportation at 8mm was lower in wave one group as compare to reciproc blue (0.358±0.03SD vs 0.5766±0.10SD, p=0.000). Mean middle canal transportation was lower in wave one gold group as compare reciproc blue (0.2483±0.02SD vs 0.3513±0.02SD, p=0.000). Mean coronal canal transportation at 8mm was lower in wave one gold group as compare to reciproc blue (0.2483±0.02 vs 0.3513±0.02SD, p=0.000) as shown.

Table 4: Comparison of apical canal transportation, middle canal transportation, and coronal canal transportation at 8mm in both groups (n=60)

| Interventional groups | n | Apical Canal transportation at 8 mm | | P value |
|---|----|-------------------------------------|---------------|---------|
| | | Mean | St. deviation | |
| Wave one Gold | 30 | 0.3580 | 0.03 | 0.000 |
| Reciproc Blue | 30 | 0.5766 | 0.10 | |
| Middle Canal transportation at 8 mm | | | | |
| Wave one Gold | 30 | 0.2483 | 0.02 | 0.000 |
| Reciproc Blue | 30 | 0.3513 | 0.02 | |
| Coronal Canal transportation at 8 mm | | | | |
| Wave one Gold | 30 | 0.2483 | 0.02 | 0.000 |
| Reciproc Blue | 30 | 0.3513 | 0.02 | |

DISCUSSION

Attaining supreme cleaning and shaping of canal during root canal therapy is challenging task for the dentists. Schneider supports the canal must be of funnel shape with minimum diameter at the apical constriction to be the supreme suitability for 3D-fluid tight seal¹. During instrumentation, most instrument used in endodontic treatment straighten the canal resulted in the working length loss.

The findings of the current research suggested that mean apical canal transportation was lower in wave one Gold groups as compare to Reciproc which showed that WaveOne Gold is better in canal preparation as compared to Reciproc. Mean middle canal transportation at 2mm was also lower in WaveOne Gold as compare to Reciproc blue. Mean coronal canal transportation was lower in WaveOne gold group as compare to Reciproc Blue. Mean apical canal transportation at 5 mm was lower in wave one gold group as compare to reciproc blue group. Mean middle canal transportation at 5mm was lower in wave one gold as compare to Reciproc blue. Mean coronal canal transportation at 5 mm was lower in wave one gold group as compare to reciproc blue group. Mean apical canal transportation at 8mm was lower in wave one group as

compare to reciproc blue. Mean middle canal transportation was lower in wave one gold group as compare reciproc blue. Mean coronal canal transportation at 8mm was lower in wave one gold group as compare to reciproc blue which is in accordance with the previous findings of the studies in comparison of One Shape, Rotary ProTaper, and Wave One systems in terms of canal transportation was made using CBCT in root with curved canals proposed that Wave One files offered the superlative results. Less canal transportation was caused by Wave One files^{6,8,10,11}. After the WaveOne primary reciprocating files and nickel-titanium (NiTi) rotary ProTaper instrumentation, the curvature of canal and axis modification was done which revealed that instrument factor was enormously important for both the CRr parameter and the rAe parameter. On using new WaveOne NiTi single-file system, reduction in canal modifications was observed^{7,8,9,17}.

These two file systems has not been studied previously but comparison has been made in terms of two motions in numerous studies^{12,13,14,15,16}. One of this type of study revealed no significant alterations between One Shape (rotary) and Wave One (reciprocating).¹⁸ The findings of the above-mentioned study was in contradiction with the findings of current study as well as the another study which concluded Wave One system as better for canal preparation while showing minimal canal as compared to Pro Taper and One Shape¹⁹.

The findings of the present study reported difference between WaveOne Gold and Reciproc blue using CBCT which was found which means that CBCT scanning as an efficient way for the evaluation of accuracy of instrumentation of root canal due to the advantages of capturing numerous images to provide the detailed information about the root canal before, during and after biomechanical preparation.²⁰⁻²⁷ To conclude that Waveone Gold had lower canal transportation than Reciproc Blue single file system using CBCT.

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