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ORIGINAL ARTICLE

Canal Transportation and Centring Ability of Reciproc and Reciproc Blue With or Without Use of Glide Path Instruments: A CBCT Study

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ABSTRACT

Objective: The objective of this ex vivo study was to evaluate canal transportation and centring ability of Reciproc and Reciproc blue systems in curved root canals with or without prior use of PathFile rotary system (PF) using Cone Beam Computed Tomography (CBCT).

Methods: One hundred and twenty curved root canals from maxillary and mandibular premolars were selected. Canals were divided randomly into 4 groups (n=30): Reciproc 25 (R25), (PF+R25), Reciproc Blue 25 (RB25), (PF+RB 25). Specimens were scanned before and after root canal preparation. Using CBCT, root canal transportation and centring ability was assessed by measuring the shortest distance from the edge of uninstrumented canal to the periphery of the root (mesial and distal) before and after preparation. Data were analysed using a one-way analysis of variance and Tukey test. The p value was set at 0.05.

Results: Less transportation and better centring ability occurred when PF was used before R25 or RB25 (P<0.0001). There was no significant difference between R25 and RB25 groups.

Conclusion: Using PF before R25 and RB25 resulted in less root canal transportation and better centring ability. The specific thermo-mechanical treatment of RB25 did not provide better results when compared to R25.

Keywords: Canal transportation, CBCT, centring ability, glide path, pre-enlargement, reciprocating single file

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HIGHLIGHTS

- A glide path enlargement with PathFile rotary system prior to root canal shaping improves the centring ability of Reciproc blue 25 and Reciproc 25 single-file systems.
- The proprietary heat treatment of Reciproc blue 25 does not decrease the canal transportation when compared to the use of M-Wire Reciproc 25.
- The impact of the use of glide path NiTi files prior to root canal shaping on canal transportation needs to be clarified.

INTRODUCTION

The final goal of root canal preparation is to shape, clean, disinfect and fill the canal space. This must be achieved by combining the mechanical action of endodontic files and chemical properties of irrigants while maintaining the original anatomy of the root canal (1). However, in case of curvatures, it is well known that mechanical preparation can lead to canal transportation (2) which may also weaken the roots, compromise disinfection and obturation of the root canal space (3). The use of Nickel-titanium (NiTi) instruments has strongly enhanced the quality of root canal shaping thanks to elastic property and flexibility of this alloy (4). In particular, these rotary systems have reduced canal transportation compared to the use of stainless-steel files (4).

In the past 10 years, single file systems used in reciprocating motion grew in popularity (5). These systems have been theoretically designed to prepare the root canal with only one instrument (6). Therefore, single file systems made the root canal shaping faster but also less gradual than the use of multiple file rotary systems (6).

Reciproc system (VDW, Munich, Germany) is made of a NiTi alloy called M-wire, created by an innovative thermal treatment process (6). The M-wire alloy and the reciprocating motion provide increased flexibility and improved resistance to cyclic fatigue (7). More recently, Reciproc Blue (VDW GmbH, Munich, Germany) has been introduced to the market. Reciproc blue and Reciproc have exactly the same geometric design. However, Reciproc blue is more flexible than Reciproc thanks to a different heat treatment (7).

Other NiTi systems have been specifically developed to be used before shaping files in order to make root canal preparation more gradual and safer (4). PathFile rotary system (Dentsply, Sirona, Bensheim, Germany) (PF) was the first of such systems including 3 files of .02 constant taper with a square cross section and an improved tip design reducing the risk of ledges and canal transportation (3).

However, up till now, contradicting findings regarding the potential benefit of glide path Niti systems to improve the centring ability of shaping files have been reported (8). Furthermore, the recent release of martensitic files with improved flexibility may make the use of glide path enlargement systems unnecessary.

The objective of this ex vivo cone-beam computed tomography (CBCT) study was to evaluate centring ability of Reciproc and Reciproc blue systems and the corresponding canal transportation in curved roots with or without prior use of PF.

MATERIALS AND METHODS

The study protocol was approved by the "Ethics Committee" of Saint Joseph University, Beirut (FMD 157).

Dental specimen

One hundred and twenty curved root canals with completely formed apices, were selected from single rooted maxillary and mandibular freshly extracted premolars. All the teeth demonstrating resorptions, fractured or immature apices were excluded from this study. Inclusion criteria included moderate to severe angles of curvature 25°<α<40°, and short radii 3.72 mm<r<10 mm. After disinfection with 5.25% sodium hypochlorite (NaOCl), teeth were stored in 10% formalin. Access cavities were prepared using a #4 high-speed round carbide bur (Dentsply, Sirona, Bensheim, Germany) with water spray. A manual glide path with a size 10 K-file (Dentsply, Maillefer, Switzerland) was performed. This file was placed into the canal until the tip of the latter was visible at the apical foramen and the working length was established 0.5-mm short of this length. Crowns were then flattened with steel disks in order to standardize the WL for each sample (WL=18mm).

Samples were fitted in the desired position by using a silicon-based impression material (3M ESPE AG Seefeld, Germany).

Cone beam computed tomography before root canal preparation

Teeth were randomly divided into 4 experimental groups, and scanned by using cone beam computed tomography (CBCT) in the HiRes Zoom Mode (NewTom VGi, Verona, Italy), with the following settings: 110 KV, 9.5 mA, a 0.125-mm voxel size, and a 0.125-mm axial thickness, to determine the root canal shape both before and after instrumentation, in exactly the same position.

Three sections per tooth were analyzed at 3, 9, 15mm from the apex to evaluate the canal transportation and centring ability in the apical, middle and coronal third.

Root canal preparation

After initial scans, root canals were instrumented by the same operator using a standardized technique.

- Group Reciproc (25/.08) (R25) (n=30)
- Group (PF+R25) (n=30)
- Group Reciproc Blue (25/.08) (RB25) (n=30)
- Group (PF+RB25) (n=30)

In groups R25 and RB25, the single file used in reciprocating movement was introduced into the canal using 3 in-and-out pecking motion about 3 mm in amplitude with light apical pressure using the corresponding pre-programmed settings of a VDW.Silver Reciproc motor (VDW, München, Germany). The canal was irrigated. Foramen patency was checked using a size 10 K-file between each file use. This protocol was repeated until WL was reached with R25 or RB25.

In the two other groups, the same protocol was applied but was preceded by a glide path enlargement with PF (13/.02, 16/.02, 19/.02 successively introduced to the working length) using the same endodontic engine at the suggested setting (300 rpm on display, 5 Ncm).

For all groups, between each file use, syringe irrigation was performed delivering 3 mL of 5.25% NaOCl. When root canal instrumentation was completed 1 mL of 15% EDTA (Wizard, Rehber Kimya San, Istanbul, Turkey) was applied for 1 min and the canals flushed again with 3 mL of NaOCl.

Cone beam computed tomography after root canal preparation

After root canal preparation, teeth were then scanned under the same conditions. Data were stored on a magnetic optical disk. The acquired pre- and postoperative images were exported to Adobe Photoshop software (Adobe Photoshop CS5, version 12.0; Adobe, San Jose, CA) and measurements were accomplished using AutoCAD software program 2013. (Fig. 1)

Evaluation of canal transportation

To compare the degree of canal transportation, a technique developed by Gambill et al. was used (9). The amount of canal transportation was determined by measuring the shortest distance from the edge of uninstrumented canal to the periphery of the root (mesial and distal) and then comparing this with the same measurements obtained from the instrumented images (Fig. 2). All values were measured by 2 calibrated evaluators, and a mean value was taken.

The following formula was used for the calculation of transportation:

$|(a1–a2)-(b1–b2)|$ where:

- a1 is the shortest distance from the mesial edge of the uninstrumented canal to the mesial edge of the root,

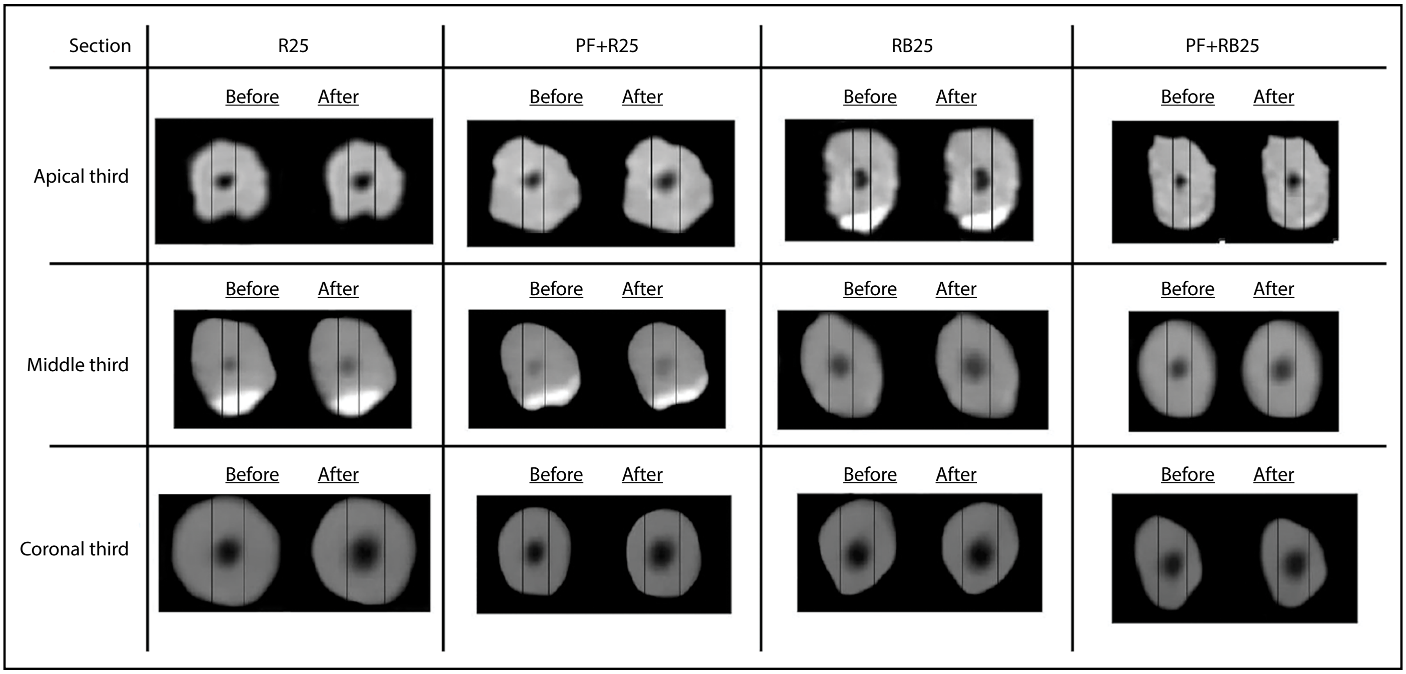

Figure 1. Apical, Middle, and coronal third cross sections before and after preparation with R25, PF+R25, RB25 and PF+RB25

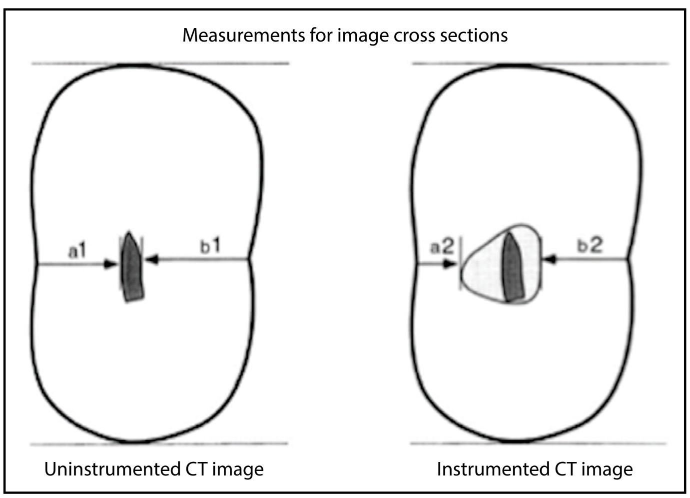

Figure 2. Representation drawing of tooth sections showing how transportation and centring ratios were derived. Uninstrumented image (left), instrumented image (right)

- b1 is the shortest distance from distal edge of the uninstrumented canal to the distal edge of the root,
- a2 is the shortest distance from the mesial edge of the instrumented canal to the mesial edge of the root,
- b2 is the shortest distance from distal edge of the instrumented canal to the distal edge of the root (Fig. 1).

According to this formula, a result other than 0 indicates that transportation has occurred into the root canal.

Evaluation of centring ability

The mean centring ratio indicates the ability of the instrument to stay centered in the canal. It was calculated for each section by using the following ratio: (a1–a2)/(b1–b2) or (b1–b2)/(a1–a2). If these numbers are not equal, the lower figure is considered as the numerator of the ratio. According to this formula, the value of 1 indicates complete centring, and the results other than 1 show a change in the original canal axis.

Data presentation and statistical analysis

Statistical analyses were performed using the statistical software package (SPSS for Windows, Version 20.0 Chicago, IL, USA). the p value was set at 0.05. The Kolmogorov-Smirnov tests were used to assess the normality of the distribution of continuous variables. One-way analysis of variance followed by post-hoc tests Tukey's Honestly Significant Different test (HSD) were conducted to explore a significant difference in mean degree of canal transportation and centring ratio between the four shaping procedures in each section of the root canal.

RESULTS

Canal transportation

The canal transportation between the 4 shaping techniques in each section of the root canal was statistically different ($P<0.0001$).

In the apical third, (PF+RB25) and (PF+R25) groups showed significantly less canal transportation than (R25) and (RB25) groups ($P<0.001$). There was no significant difference between groups (R25) and (RB25) ($P=0.422$).

In the middle third, (PF+RB25) and (PF+R25) groups showed significantly less canal transportation than (R25) and (RB25) groups ($P=0.050$). There was no significant difference between (R25) and (RB25) groups ($P=0.866$) and between (PF+RB25) and (PF+R25) groups ($P=0.764$).

In the coronal third, (PF+RB25) and (PF+R25) groups showed significantly less canal transportation than (R25) and (RB25) groups ($P=0.030$); the difference was not significant between (R25) and (RB25) groups ($P=0.980$) (Table 1).

TABLE 1. Absolute Values of Mean Canal Transportation (mm±standard deviation) for the Coronal, Middle, and Apical Thirds after preparation with R25, PF+R25, RB25 and PF+RB25

Groups	Apical third	Middle third	Coronal third
R25 (n=30)	0.0612±0.0581[b]	0.0532±0.0534[b]	0.0477±0.0607[b]
PF+R25 (n=30)	0.0420±0.0332[a, b]	0.0330±0.0300[a]	0.0361±0.0297[a, b]
RB25 (n=30)	0.0463±0.0327[b]	0.0514±0.0407[b]	0.0519±0.0418[b]
PF+RB25 (n=30)	0.0207±0.0130[a]	0.0298±0.0352[a]	0.0223±0.0236[a]

Values with the same superscript letter were not statistically different

TABLE 2. Root canal centring ability (mm±standard deviation) for the Coronal, Middle, and Apical Thirds after preparation with R25, PF+R25, RB25 and PF+RB25

Groups	Apical third	Middle third	Coronal third
R25 (n=30)	0.5455±0.2829[a]	0.5914±0.2292[a]	0.6297±0.2491[a]
PF+R25 (n=30)	0.6711±0.1891[b]	0.7450±0.1508[b]	0.7606±0.1927[b]
RB25 (n=30)	0.5723±0.2604[a]	0.6142±0.2064[a]	0.6056±0.2882[a]
PF+RB25 (n=30)	0.6862±0.1538[b]	0.7783±0.1452[b]	0.7729±0.1764[b]

Values with the same superscript letter were not statistically different

Centring ability

There was a significant difference in mean centring ratio between the four shaping techniques in each section of the root canal (P<0.0001). The centring ratio was significantly higher in groups (PF+RB25) and (PF+R25) and smaller in groups (R25) and (RB25) in the Middle and Apical Third (Table 2).

DISCUSSION

The objective of the present study was to evaluate the effects of a previous glide path enlargement with PF on canal transportation and centring ability of two single files used in reciprocating motion: R25 and RB25.

In the present study, all systems led to a certain degree of canal transportation. No significant difference was observed between R25 and RB25. However, a previous glide path enlargement using PF clearly reduced canal transportation and resulted in better centring ability of both single file systems.

Some previous studies investigating centring ability of different file systems have been performed in artificial canals for reproducibility and calibration of the experimental design (10-12). However, simulators such as resin blocks do not perfectly mimick natural dentine hardness, structure and anatomy, preventing reliable extrapolation of the results to those obtained in natural teeth. In the present study a consistent number of extracted teeth was selected to counterbalance the difficulty involved with standardization of the specimens as reported by other authors (13, 14). Moreover, for pertinent assessment of canal transportation and centring ability, curved canals were selected with meticulous inclusion criteria taking into consideration angles of curvature and radii (15, 16). The WL of each specimen was also standardized for better comparison between the groups.

CBCT is an effective method for measuring dentine thickness, canal transportation and centring ability used in many recent studies (17, 18). In the present study, it was decided to use this noninvasive method providing detailed three-dimensional observations at a smaller field of view. CBCT allows multiple imaging before and after root canal instrumentation but the resolution of this tool is lower than the one of microCT (17). However, in the present study, since a manual glide path with a size 10 K-file was possible, a 0.125-mm voxel size was considered appropriate to detect the canals and perform accurate measurements (19). In addition, microCT imaging technique, despite its higher resolution, is well known to be time-consuming especially for a high number of dental samples like the one used in our study (n=120). If the recent versions of microCT scanners have overcome this problem, the overall cost of this technique remains higher than the one of CBCT technology.

Finally, the mathematic formula of Gambill et al. (9) was used in this work to quantify the centring ability thus avoiding the use of subjective assessment by different evaluators. Performing measurements at three levels from the apex to the canal orifice is a well-known methodology to evaluate the canal transportation and centring ability in the apical, middle and coronal third where the risk of procedural errors is higher (17).

In the past few years, a considerable number of rotary systems used in continuous or reciprocating motion has been introduced to the market based on multiple evolutions on NiTi alloy (heat treatments) (7), kinematics (20), file design (21) and number of files (multiple or single file) (22). These changes strongly contributed to improve the overall shaping properties while reducing the risk of file separation (7). In the present study, even though all systems produced a certain degree of canal transportation as it was shown in several investigations (21, 23), no significant differences were observed between R25 and RB25. These findings are in accordance with those of previous studies that showed that the proprietary heat treatment of RB25 did not result in less canal transportation and better centring ability when compared to R25 (24). This may be explained by the fact that except the Niti alloy, R25 and RB25 have exactly the same geometric characteristics (cross section, taper and tip) (24). Furthermore, the M-Wire alloy has already been considered as a clear improvement in terms of flexibility compared to other NiTi alloys (23).

Creating a glide path enlargement has been recommended before using NiTi rotary file systems (3). In the present study, both shaping systems had the same performance, but the creation of a previous glide path enlargement using PF clearly reduced canal transportation and resulted in better centring ability of R25 and RB25. Our findings can be explained by the fact that the use of glide path NiTi system based on the use of 3 instruments before a single shaping file may make the root canal preparation more gradual leading to a better respect of the original anatomy. On the other hand, some authors have shown that performing a glide path enlargement had no effect on the centring ability when using WaveOne Gold or Reciproc (25-27). These different findings could be explained by a lack of standardization between the methodologies especially by taking into account that some studies were conducted on simulated root canals. Finally, the use of other types of glide path instruments with different features may also lead to contradicting results.

CONCLUSION

Within the limitations of this study, performing a glide path enlargement with PF improved the centring ability of R25 and RB25 single-file systems and decreased the canal transportation. The proprietary thermomechanical treatment of RB25 did not affect the canal transportation nor the centring ability when compared to the use of M-wire R25. Nevertheless, further investigations are needed to clarify the role played by the heat treatment technology and the use of glide path NiTi files prior to root canal shaping.

Disclosures

Conflict of interest: The authors declare no conflict of interest.

Ethics Committee Approval: The study protocol was approved by the "Ethics Committee" of Saint Joseph University, Beirut (FMD 157).

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REFERENCES

1. Schilder H. Cleaning and shaping the root canal. Dent Clin North Am 1974; 18(2):269–96.
2. Abou-Rass M, Frank AL, Glick DH. The anticurvature filing method to prepare the curved root canal. J Am Dent Assoc 1980; 101(5):792–4. [CrossRef]
3. West JD. The endodontic Glidepath: "Secret to rotary safety". Dent Today 2010; 29(9):86–93.
4. Peralta-Mamani M, Rios D, Duarte MAH, Santiago Junior JF, Honório HM. Manual vs. rotary instrumentation in endodontic treatment of permanent teeth: A systematic review and meta-analysis. Am J Dent 2019; 32(6):311–24.
5. Grande N, Plotino G, Ahmed HM, Cohen S, Bukiet F. The reciprocating movement in endodontics. Endodontic practice 2016; 28–33.
6. Yared G, Alasmar Ramli G, Single file reciprocation: A literature review. ENDO 2013; 7(3):171–8.
7. De-Deus G, Silva EJ, Vieira VT, Belladonna FG, Elias CN, Plotino G, et al. Blue Thermomechanical Treatment Optimizes Fatigue Resistance and Flexibility of the Reciproc Files. J Endod 2017; 43(3):462–6. [CrossRef]
8. Hartmann RC, Peters OA, de Figueiredo JAP, Rossi-Fedele G. Association of manual or engine-driven glide path preparation with canal centring and apical transportation: a systematic review. Int Endod J 2018; 51(11):1239–52. [CrossRef]
9. Gambill JM, Alder M, del Rio CE. Comparison of nickel-titanium and stainless steel hand-file instrumentation using computed tomography. J Endod 1996; 22(7):369–75. [CrossRef]
10. Berutti E, Cantatore G, Castellucci A, Chiandussi G, Pera F, Migliaretti G, et al. Use of nickel-titanium rotary PathFile to create the glide path: comparison with manual preflaring in simulated root canals. J Endod 2009 Mar; 35(3):408–12. [CrossRef]
11. Berutti E, Chiandussi G, Paolino DS, Scotti N, Cantatore G, Castellucci A, et al. Canal shaping with WaveOne Primary reciprocating files and ProTaper system: a comparative study. J Endod 2012; 38(4):505–9. [CrossRef]
12. Pasqualini D, Scotti N, Tamagnone L, Ellena F, Berutti E. Hand-operated and rotary ProTaper instruments: a comparison of working time and number of rotations in simulated root canals. J Endod 2008; 34(3):314–7. [CrossRef]
13. De-Deus G, Arruda TE, Souza EM, Neves A, Magalhães K, Thuanne E, et al. The ability of the Reciproc R25 instrument to reach the full root canal working length without a glide path. Int Endod J 2013; 46(10):993–8.
14. Bane K, Faye B, Sarr M, Niang SO, Ndiaye D, Machtou P. Root canal shaping by single-file systems and rotary instruments: a laboratory study. Iran Endod J 2015; 10(2):135–9.
15. Schneider SW. A comparison of canal preparations in straight and curved root canals. Oral Surg Oral Med Oral Pathol 1971; 32(2):271–5. [CrossRef]
16. Lopes HP, Elias CN, Estrela C, Siqueira JF Jr. Assessment of the apical transportation of root canals using the method of the curvature radius. Braz Dent J 1998; 9(1):39–45. [CrossRef]
17. Hassan R, Roshdy N, Issa N. Comparison of canal transportation and centering ability of Xp Shaper, WaveOne and Oneshape: a cone beam computed tomography study of curved root canals. Acta Odontol Latinoam 2018; 31(1):67–74. [CrossRef]
18. Hasheminia SM, Farhad A, Sheikhi M, Soltani P, Hendi SS, Ahmadi M. Cone-beam Computed Tomographic Analysis of Canal Transportation and Centering Ability of Single-file Systems. J Endod 2018; 44(12):1788–91. [CrossRef]
19. Moghadam KN, Zadeh NF, Labbaf H, Kavosi A, Zadeh HF. Negotiation, Centering Ability and Transportation of Three Glide Path Files in Second Mesiobuccal Canals of Maxillary Molars: A CBCT Assessment. Iran Endod J 2019; 4(14):47–51.
20. Grande NM, Ahmed HM, Cohen S, Bukiet F, Plotino G. Current Assessment of Reciprocation in Endodontic Preparation: A Comprehensive Review-Part I: Historic Perspectives and Current Applications. J Endod 2015; 41(11):1778–83. [CrossRef]
21. Kandaswamy D, Venkateshbabu N, Porkodi I, Pradeep G. Canal-centering ability: An endodontic challenge. J Conserv Dent 2009; 12(1):3–9. [CrossRef]
22. de Carvalho GM, Sponchiado Junior EC, Garrido AD, Lia RC, Garcia Lda F, Marques AA. Apical Transportation, Centering Ability, and Cleaning Effectiveness of Reciprocating Single-file System Associated with Different Glide Path Techniques. J Endod 2015; 41(12):2045–9. [CrossRef]
23. Pansheriya E, Goel M, Gupta KD, Ahuja R, Kaur RD, Garg V. Comparative Evaluation of Apical Transportation and Canal Centric Ability in Apical Region of Newer nickel-titanium File Systems Using cone-beam computed tomography on Extracted Molars: An In Vitro Study. Contemp Clin Dent 2018; 9(Suppl 2):S215–20. [CrossRef]
24. Belladonna FG, Carvalho MS, Cavalcante DM, Fernandes JT, de Carvalho Maciel AC, Oliveira HE, et al. Micro-computed Tomography Shaping Ability Assessment of the New Blue Thermal Treated Reciproc Instrument. J Endod 2018;44:1146–50. [CrossRef]
25. Vorster M, van der Vyver PJ, Paleker F. Canal Transportation and Centering Ability of WaveOne Gold in Combinationwith and without Different Glide Path Techniques. J Endod 2018; 44(9):1430–5. [CrossRef]
26. Coelho MS, Fontana CE, Kato AS, de Martin AS, da Silveira Bueno CE. Effects of Glide Path on the Centering Ability and Preparation Time of Two Reciprocating Instruments. Iran Endod J 2016; 11(1):33–7.
27. Bürklein S, Poschmann T, Schäfer E. Shaping ability of different nickel-titanium systems in simulated S-shaped canals with and without glide path. J Endod 2014; 40(8):1231–4. [CrossRef]