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Comparative Evaluation of Shaping Ability of Plex V and Neoendo S Files in Curved Canals Using Cone-Beam Computed Tomography: An In vitro Study

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Abstract

Background: *The objective of the study was to assess and compare the canal transportation and centering ability during the preparation of curved root canals, utilizing the PLEX V kit (Orodeka) and Neoendo S (Orikam) files, analyzed through cone-beam computed tomography (CBCT).*
Materials and Methods: *Twenty single-rooted extracted human teeth, with root curvature were selected for this study. Samples were randomly allocated into two groups: Plex V and Neoendo S. Instrumentation was performed in accordance with the manufacturers' guidelines. Canals were scanned using a CBCT scanner before and after preparation to evaluate the transportation and centering ratios at 3 mm and 5 mm from the apex.*
Results: *At the 3 mm level, PLEX V demonstrated a higher mean centering ratio compared to NEOENDO S. At 5mm level also Plex V showed a higher canal centering ability and the difference was more pronounced.*
When comparing canal transportation between these two files NEOENDO S showed a higher canal transportation value than Plex V, and the difference was more pronounced at 5 mm.
Conclusion: *Hence, it is concluded that Plex V files showed better canal centering ratio as well as lesser canal transportation when compared with NEOENDO S files.*
Keywords: *CBCT, Canal centering ability, Canal transportation, Neoendo S, Plex V.*

INTRODUCTION

The main aim of root canal instrumentation is to achieve complete and centered integration of the original canals into the prepared shape, which implies that all surfaces of the root canal are mechanically prepared. It has become evident that this objective is unlikely to be accomplished using any mechanical shaping techniques.[1,2] Furthermore, preparation errors such as ledge and block formation, apical zipping, and perforations should be completely avoided. Although these adverse consequences of canal shaping and other procedural errors may not directly influence the likelihood of a favourable outcome,[3] they render portions of the root canal system inaccessible for disinfection, making them undesirable for that reason alone. Another significant mechanical goal is to preserve as much cervical and radicular dentine as possible to avoid compromising the root structure, thus preventing root fractures. Prior to root canal shaping, anatomical studies have shown that dentine wall thickness dimensions of 1 mm and below are present.[4,5] The straightening of canal paths can result in the precarious thinning of curved root walls. While a definitive minimal radicular wall thickness has not been scientifically determined, a dentine thickness of 0.3 mm is regarded as critical.[6] Concerning the overall shape, it has been suggested that canals should be prepared with a uniform and continuous taper;[7] however, this principle was designed to facilitate a specific root filling technique rather than to improve antimicrobial efficacy. For optimal disinfection, the relationship between preparation shape and antimicrobial efficacy is crucial, as it involves the efficient removal of infected pulp and dentine and the creation of space for the delivery of irrigants.

Given that the cleaning and shaping of the root canal is a key procedure in endodontic treatment that influences subsequent steps in the process,[8] there is a constant effort among researchers and manufacturers to develop the perfect alloy and instrument design for minimally invasive preparation while preserving the remaining dentin thickness.[9] Continuous research in Nickel-titanium (NiTi) rotary instruments aims to enhance their cutting and shaping capabilities, showing that these instruments achieve a more centered canal preparation with less transportation compared to stainless steel instruments. The progress in the NiTi rotary field requires dental practitioners to conduct a thorough evaluation of these systems to help them choose one of the best available options. Recently, Orodeka (Shandong, China) has introduced the PLEX V kit, which consists of a set of rotary endodontic files.

- Plex V 04: Includes **15/0.8, 15/0.3, 20/0.4, 25/0.4**
- Plex V 06: Includes **15/0.8, 15/0.3, 20/0.5, 25/0.6**

Neoendo S is another high-performance nickel-titanium (NiTi) rotary file system developed by Orikam Healthcare (China), designed for efficient and flexible root canal preparation.

Sizes available:

- Neoendo S 04 : **includes 17/0.4, 20/0.4 ,25/0.4 ,30/0.4, 35/0.4**
- Neoendo S 06: **includes 20/0.6, 25/0.6 , 30/0.6, 35/0.6**

Properties

Plex V

- Triangular convex section
- Controlled memory wire
- Shape memory
- Resistance to torsional and flexural fatigue
- Pre-curved designs

Neoendo S

- Progressively increasing pitch
- S-shaped cross-section
- Safety non-cutting
- High fracture resistance
- Excellent flexibility
- Sharp cutting flutes.

Objectives

To compare the canal transportation and canal centering ability in the preparation of curved root canals after instrumentation with Neoendo S and Plex V files using cone-beam computed tomography (CBCT).

METHODOLOGY

A total of 20 single-rooted permanent mandibular premolars, extracted for orthodontic purposes, were selected. The roots were secured in a custom-designed specimen holder. Access to the teeth was achieved using an Endo-Access bur (Dentsply Maillefer) with a high-speed handpiece. Canal patency was established by inserting size 10 K-files (Dentsply Maillefer) into the canals, and the curvature of the canals was assessed following Schneider's method. Teeth exhibiting any visible cracks, fractures, calcifications, or those that had undergone previous root canal treatments were excluded from the study. The working length was determined using Ingle's method. The teeth were randomly divided into two groups, namely Group 1 Plex V and Group 2 Neoendo S (n = 10 for each group).

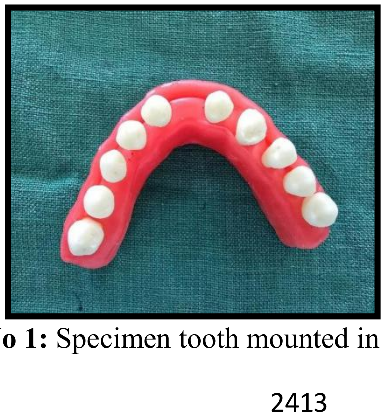


Fig No 1: Specimen tooth mounted in wax.

Root Canal Shaping

The canals were instrumented by a single operator in accordance with the manufacturer's guidelines for both systems. An electric motor (Eighteeth, Orikam, China) was utilized to operate the files. A stainless steel #15 K-file was employed to create a glide path up to the predetermined working length. For Group 1 Plex V, the root canals were instrumented using the Plex V orifice opener, followed by the Plex V glider and the Plex V shaping file. The instrumentation sequence for the root canals in Group 2 Neoendo S was as follows: 30/08, 17/04, 20/04, and 25/04.

Image analysis

The roots were aligned perpendicularly to the beam and were scanned before and after instrumentation using the CBCT scanner (New Tom Giano) operating at 90kV, 8 mA. The field of view was 10x6 cm.

Cone-beam computed tomography measurements

Pre- and post-instrumentation measurements of canals were achieved using the CBCT NNT viewer software.

• Canal transportation and centering ratio were determined at two cross-section levels, specifically at 3mm and 5mm from the apical end of the root, utilizing the following equation.

• Degree of canal transportation = (X1-X2) - (Y1-Y2)

• Canal centering ratio = (X1-X2) / (Y1-Y2) if (X1-X2) < (Y1-Y2) or (Y1-Y2) / (X1-X2) if (Y1-Y2) < (X1-X2).

Where,

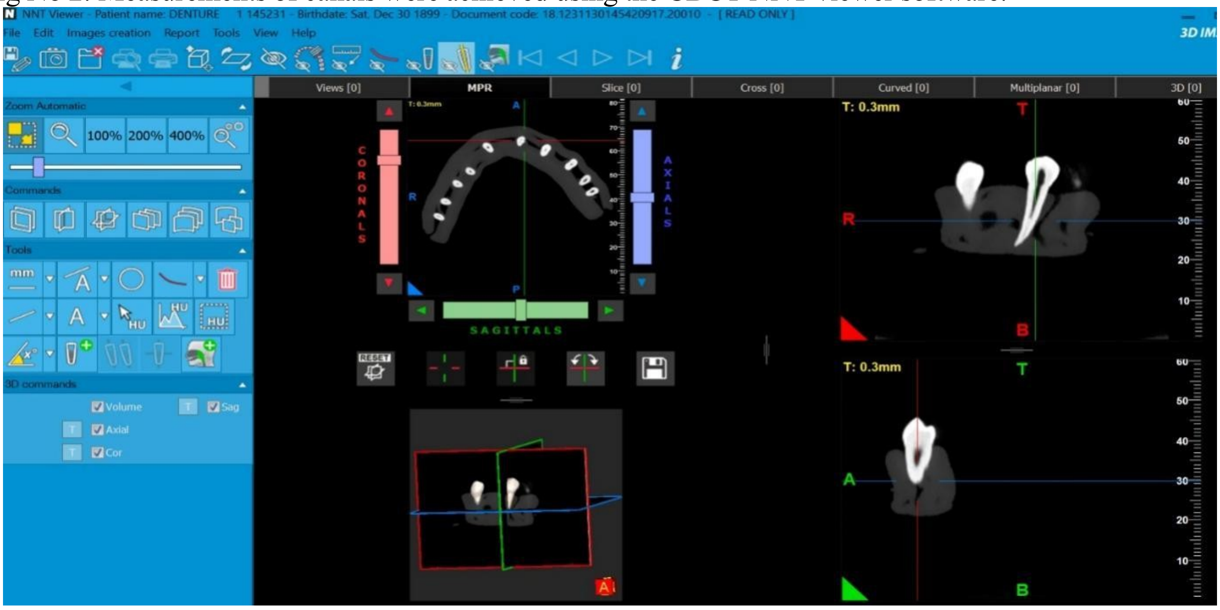
• 1. X1 - the shortest distance from the mesial edge of the root to the mesial edge of the uninstrumented canal

• 2. X2 - the shortest distance from the mesial edge of the root to the mesial edge of the instrumented canal

• 3. Y1 - the shortest distance from the distal edge of the root to the distal edge of the uninstrumented canal

• • 4. Y2 - the shortest distance from the distal edge of the root to the distal edge of the instrumented canal

Fig No 2: Measurements of canals were achieved using the CBCT NNT viewer software.



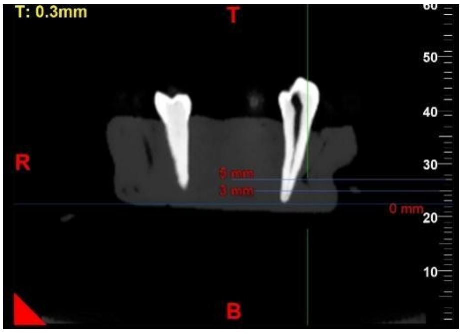


Fig No 3: Canal transportation and centering ratio were calculated at two cross-section levels, i.e., **3mm and 5mm** from the apical end.

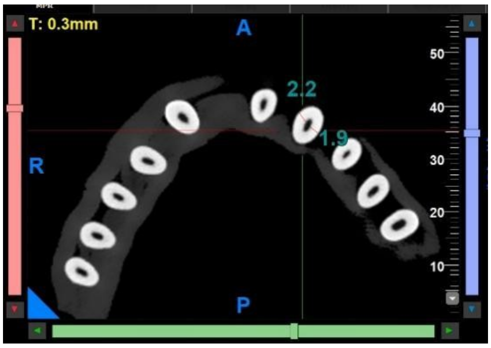


Fig No 4: Measurements taken from CBCT

Statistical analysis

Data was analyzed using the statistical package **SPSS 26.0** (SPSS Inc., Chicago, IL) and level of significance was set at **p<0.05**. **Descriptive statistics** was performed to assess the mean and standard deviation of the respective groups. **Inferential statistics** to find out the difference between the groups was done using **Independent T test.**

RESULTS

The comparison of canal centering ratios between NEOENDO S and PLEX V at 3 mm and 5 mm levels from the apex reveals statistically significant differences. At the 3 mm level, PLEX V demonstrated a higher mean centering ratio (0.730) compared to NEOENDO S (0.610), with a mean difference of 0.12. This difference was statistically significant, with a p-value of 0.04. At the 5 mm level, the difference was more pronounced, with PLEX V showing a mean ratio of 0.780 versus 0.530 for NEOENDO S. The mean difference of 0.25 was highly significant (p = 0.0006).

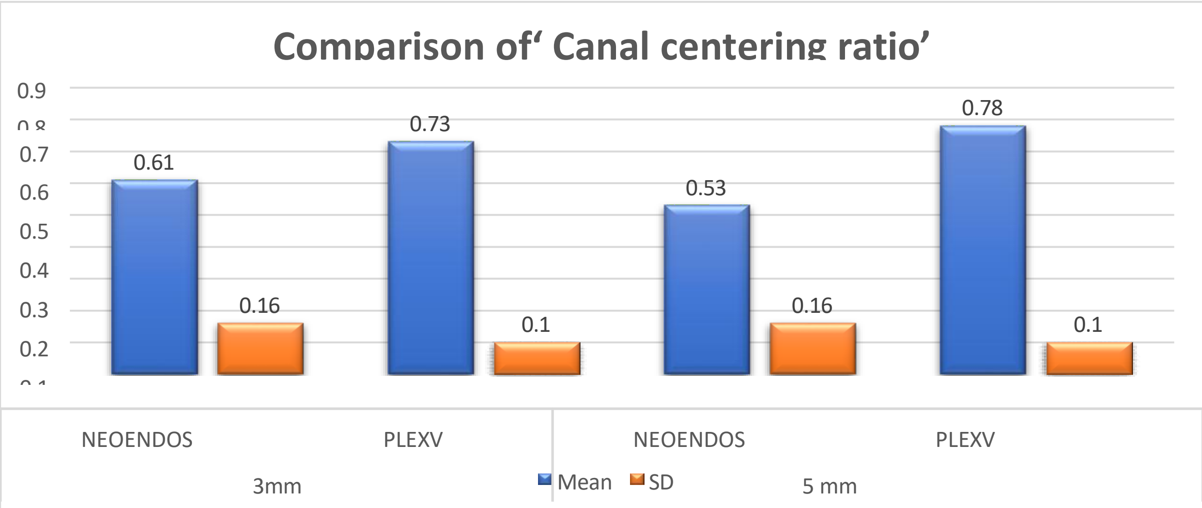
Table1-Comparison of 'Canal centering ratio'

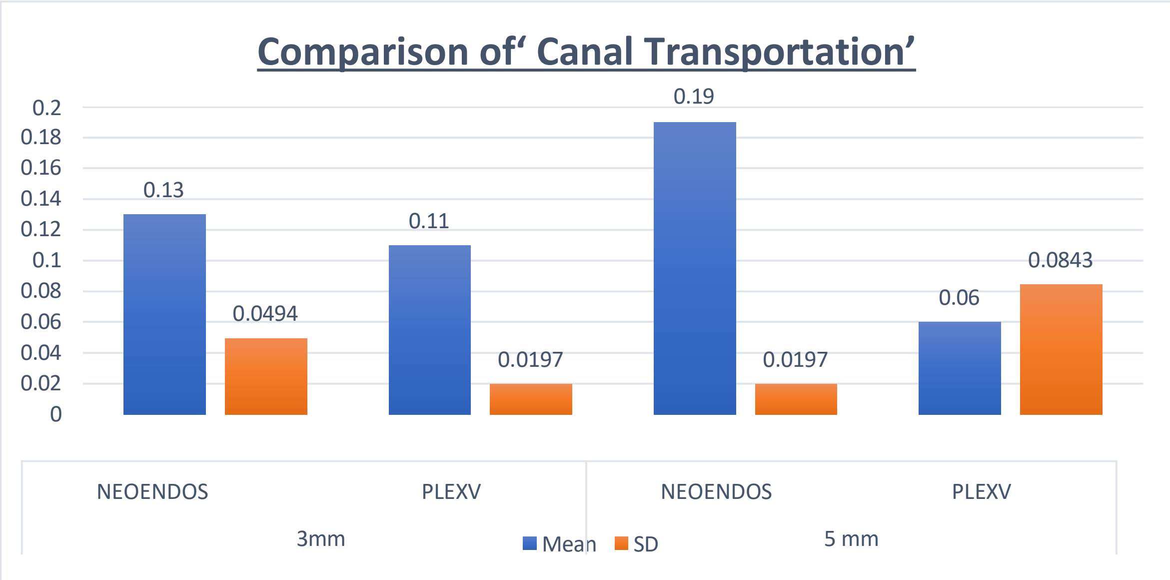
		Mean	N	Std. Deviation	Std. Error Mean	T Value	P Value	Mean Difference
3mm	**NEOENDO S**	**.610**	**10**	**.1665**	**.1159**	**2.02**	**0.04***	**0.12**
	PLEX V	**.730**	**10**	**.1020**	**.0955**			
5 mm	**NEOENDO S**	**.530**	**10**	**.1669**	**.0844**	**4.19**	**0.0006***	**0.25**
	PLEX V	**.780**	**10**	**.1048**	**.0964**			

Table 2-Comparison of‘ Canal Transportation’

		Mean	N	Std. Deviation	Std. Error Mean	T Value	P Value	Mean Difference
3mm	NEOENDO S	.130	10	.0494	.0473	1.5	0.14	0.02
	PLEX V	.110	10	.0197	.0379			
5 mm	NEOENDO S	.190	10	.0197	.0379	5.09	0.0001*	0.13
	PLEX V	.060	10	.0843	.0267			

The comparison of canal transportation between NEOENDO S and PLEX V at two different levels (3 mm and 5 mm from the apex) revealed distinct differences in performance. At the 3 mm level, NEOENDOS exhibited a slightly higher mean transportation value (0.130mm) compared to PLEX V (0.110mm); however, this difference was not statistically significant (P=0.14). In contrast, at the 5mm level, NEOENDO S demonstrated significantly greater canal transportation (mean = 0.190 mm) than PLEXV (mean=0.060mm), with the difference being statistically significant (P=0.0001).





DISCUSSION

Canal transportation is defined in the glossary of endodontic terminology as the removal of canal wall structure along the outer curve in the apical half of the canal. This phenomenon occurs due to the tendency of files to revert to their original linear configuration during canal preparation, which may lead to the formation of ledges and the risk of perforation. The centering ratio acts as a measure of the instrument's capability to maintain its position at the center of the canal. A lower ratio suggests that the instrument is more likely to stay centered within the canal.[11]

In this study, canal transportation was evaluated using the formula proposed by Gambill et al: (X1 - X2) - (Y1 - Y2).[10,11] Here, X1 denotes the shortest distance from the canal's exterior to the edge of the uninstrumented canal. Y1 represents the shortest distance from the root's interior to the edge of the uninstrumented canal. X2 indicates the shortest distance from the root's exterior to the edge of the instrumented canal. Y2 signifies the shortest distance from the root's interior to the edge of the instrumented canal. If the result obtained from this calculation using the specified formula equals 0, it indicates that there is no canal transportation.

The centering ratio was also calculated using the formula developed by Gambill et al.: (X1 - X2) / (Y1 - Y2).[10,12] In this scenario, if (X1 - X2) and (Y1 - Y2) are not equal, the smaller value is utilized as the numerator of the ratio, and a result of one derived from the formula signifies perfect canal centering by the instrument used.

This research compared the canal transportation and centering capabilities of two distinct NiTi rotary systems, namely PLEX V (Orodeka) and Neoendo S (Orikam Healthcare). Plex V is a recently introduced set of rotary endodontic files. It is available as assortment Packs: Plex V 04: Includes 15/0.8, 15/0.3, 20/0.4, 25/0.4 and Plex V 06: Includes 15/0.8, 15/0.3, 20/0.5, 25/0.6. It is a controlled memory wire with triangular convex section, shape memory and pre-curved designs. It has resistance to torsional and flexural fatigue.

Neoendo S files are available in sizes of 17,20,25,30,35 with 4% and 6%. Lengths available are 21mm and 25mm. While Neoendo S has progressively increasing pitch, safety non-cutting tip, high fracture resistance excellent flexibility, sharp cutting flutes and S-shaped cross-section. This research sought to evaluate the canal transportation and the ability to center the canal during the preparation of curved root canals following the use of Plex V and Neoendo s files, utilizing cone-beam computed tomography (CBCT).

At the 3 mm level, PLEX V demonstrated a higher mean centering ratio compared to NEOENDO S indicating better centering ability of PLEX V in the apical third.

At the 5 mm level, there was a significant difference in the performance of the two files.The results suggest a superior performance of PLEX V in maintaining canal centricity in the middle third of the root canal.

The comparison of canal transportation between NEOENDO S and PLEX V at two different levels (3 mm and 5 mm from the apex) revealed distinct differences in performance. At the 3 mm level, NEOENDO S exhibited a slightly higher mean transportation value compared to PLEX V. according to the results both systems performed similarly in maintaining canal anatomy at this level. In contrast, at the 5 mm level, NEOENDO S demonstrated significantly greater canal transportation than that at 3mm level. This suggests that PLEX V maintains the original canal curvature more effectively at the 5 mm level, potentially reducing the risk of procedural errors associated with canal deviation. Plex V showed better results when compared to Neoendo S may be due to exclusive metallurgical property i.e. controlled memory, superior flexibility and fatigue resistance.[14,15]

CONCLUSION

PLEX V exhibited superior canal centering ability compared to NEOENDO S at both 3 mm and 5 mm levels from the apex, with a more marked advantage observed at the 5 mm level, corresponding to the middle third of the canal. In terms of canal transportation, both systems showed comparable performance at the 3 mm level; however, at 5 mm, PLEX V demonstrated significantly less transportation than NEOENDO S. Overall, PLEX V more effectively preserved the original canal curvature, particularly in the middle third, indicating its potential to minimize procedural errors related to canal deviation during root canal instrumentation.

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