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Comparison of Canal Transportation by Two Rotary Systems, Neoniti vs. Wave One, Both Used with Reciprocal Motion

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A B S T R A C T

Objectives: Preserving the original canal morphology is the ideal goal during root canal preparation. This study aimed to compare canal transportation at various cross-sections using the Neoniti and Wave One Gold rotary systems, both applied with reciprocal motion.

Materials and Methods: Forty acrylic S-shape canal simulator endo-blocks were used in this study. Two preparation protocols were applied: (1) Proglider (#16/0.02) followed by Wave One Gold (#20/0.07) and (2) GPS followed by A1#20 (reciprocal motion). The canals were dyed before and after preparation, and images were captured from both stages using blocks. These images were then superimposed using Adobe Photoshop to assess differences, and measurements were taken with Digimizer image analysis software. The data was analyzed using an independent samples T-test, with statistical significance set at $P<0.05$.

Results: Transportation was significantly greater in the middle third of the canal simulator in the group that was treated with Proglider (#16/0.02) followed by Wave One Gold (#20/0.07). However, no significant differences were observed in the coronal or apical thirds.

Conclusion: While the manufacturer of Neoniti recommends using this system with continuous rotational motion, it can also be effectively utilized with reciprocal motion, yielding satisfactory results while respecting the canal anatomy.

Keywords: Root Canal Preparation; Endodontics; Root Canal Therapy

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INTRODUCTION

One of the most critical steps in root canal therapy is the cleaning and shaping of the root canal system, which aims to eliminate or significantly reduce intra-canal microorganisms while maintaining the original anatomy of the root canal system [1]. During an ideal root canal preparation the original canal morphology is preserved, while flaring the canal from coronal to apical portion along with preserving the apical foramen [2]. However, the complexity of the root canal anatomy may compromise the ideal root canal preparation. One of the most common challenges clinicians face, is various canal curvatures in the root canals. The curvatures of the canals can impede the ideal mechanical preparation of the root canals, which may result in procedural errors. [3]. As a result, preparation of S-shaped canals has always been challenging for dental clinicians. Canal transportation is a procedural mishap that changes the shape of the canal and makes the treatment prognosis guarded. Canal transportation may be followed by zipping or perforation of the root [4]. Introduction of nickel-titanium (NiTi) rotary systems into endodontic practice was in hope of

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less procedural errors, i.e. canal transportation, zip, ledge and striping perforation [3].

Single-file rotary systems can be grouped into two categories, namely rotating and reciprocating files. Neoniti A1 (NEOLIX, Châtres-la-Forêt, France) is a single-file system that exhibits full rotary motion. It is composed of a special alloy that provides improved flexibility. The system is available in three different sizes—20/0.08, 25/0.08, and 40/0.08—and is suggested to be employed at a speed of 300 to 500 rpm with a torque limit of 1.5N/cm. The manufacturer claims that the system's advantages include sharp cutting edges, a single-file technique, a Gothic-like tip design, and built-in abrasive properties. [5].Wave One Gold (WOG) (Dentsply Maillefer, Ballaigues, Switzerland), is another single-file system with a reciprocating motion. These files are made using a specific thermal procedure, leading to the development of a superelastic NiTi file. The gold process is a post-manufacturing procedure through which the NiTi files would be heat treated and slowly cooled. Giving the file its gold finish, this procedure also improves strength and flexibility; especially when compared with Wave One. WOG is available in four different sizes: small (20.07 inches, yellow), primary (25.07 inches, red), medium (35.06 inches, green), and large (45.05 inches, white). Its cross section is a parallelogram with two 85-degree cutting edges that make one and two-point contact alternately. [6].

Reciprocal motion involves a larger counter-clockwise rotating angle for cutting dentin and a smaller clockwise angle for disengagement [7]; the counterclockwise angle allows the instrument to move continuously towards the root canal apex [8,9]. It is indicated that using a single NiTi instrument with reciprocating motion yields better outcomes compared to the traditional continuous rotation motion for preparing curved root canals [10]. This motion reduces stress on the instrument, lowers the risk of fracture, and enhances the cyclic fatigue resistance and longevity of NiTi instruments [9,11].

The present study aimed to compare Neoniti and Wave One Gold rotary systems both used with reciprocal motion in terms of canal transportation at different cross-sections.

MATERIALS AND METHODS

The current investigation was conducted on 40 S-shaped canal simulator endo-blocks (E-block, Acadental, USA), assigned to two groups using two different systems for preparation: 1) Proglider file (#16, 0.02) (Dentsply Maillefer, Ballaigues, Switzerland) +Wave One Gold (#20, 0.07) (Dentsply Maillefer, Ballaigues, Switzerland), 2) GPS (NEOLIX, Châtres-la-Forêt, France) + A1 (#20) (NEOLIX, Châtres-la-Forêt, France) with reciprocal motion. Canal cross-section diameter was 0.2mm. In each group a path file (*i.e.* Proglider, GPS) was used to make a glide path followed by a single-file rotary system with reciprocal motion, all done by Endo Pilot motor (Schlumbohm, Brokstedt, Germany). In the first group files were used according to the manufacturer's catalogue [6]. Preparation was conducted in the second group using a speed of 300 rpm and a torque of 2Ncm. The reciprocal motion was manually calibrated with a timing sequence of 70 milliseconds for leftward movement, followed by a 1-millisecond pause, and then a 210-millisecond rightward movement. This sequence represents a 150° counterclockwise motion followed by a 360° clockwise motion in each cycle, as determined from slow-motion video analysis. The canal space of each block was dyed red and yellow once before and once after preparation, respectively, and photographed using a Dino-Lite AM4113TL stereomicroscope (AnMo Electronics Corporation, New Taipei City, Taiwan). (Figure 1)

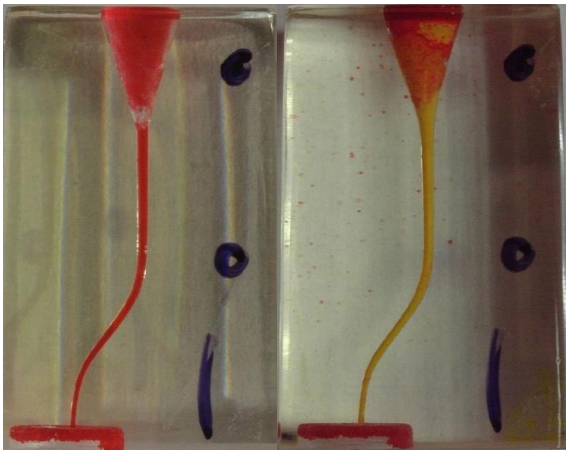

Fig 1. Endoblocks before (a) and after (b) preparation

Before- and after-preparation images were merged in Adobe PhotoShop CC 2019 (Adobe

Inc., San Jose, California). Ten cross-sections of the blocks with one millimeter interval were evaluated using Digimizer image analysis software (MedCalc Software Ltd. Ostend, Belgium). Absolute canal transportation at each cross-section was determined by calculating half of the absolute difference between the transportation measurements on the left and right sides. The average absolute canal transportation at the first, second, and third cross-sections was considered apical canal transportation. The average absolute canal transportation at cross-sections four, five, six and seven was considered middle canal transportation. Likewise, the average absolute canal transportation at the eighth, ninth, and tenth cross-sections was considered coronal canal transportation. (Figure 2)

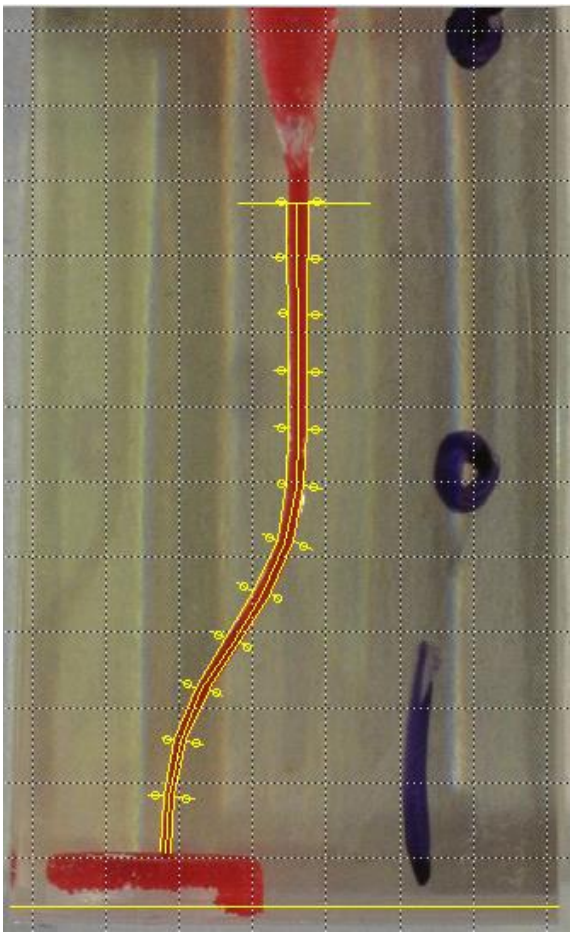

Fig 2. Pattern for transportation measurement at 1mm cross sections

To compare the group's transportation at each of the 3 levels, independent samples T test was used. A P-value less than 0.05 was considered statistically significant.

RESULTS

In the apical third, the GPS+A1 group exhibited less canal transportation, although this difference was not statistically significant. In contrast, the GPS+A1#20 group, which utilized reciprocal motion, showed significantly reduced transportation in the middle third (P<0.001). In the coronal third, no statistically significant differences were observed between the two groups, despite the GPS+A1#20 group displaying higher transportation levels (Table 1).

Table 1. Transportation in apical, middle, and coronal thirds (mm)

	Apical	Middle	Coronal
GPS + A1#20	0.17±0.04	0.25±0.04	0.12±0.05
Proglider + Wave One	0.18±0.05	0.32±0.05	0.10±0.03
P	0.52	<0.001*	0.15

DISCUSSION

Root canal treatment outcome is basically dependent upon the quality of cleaning, shaping, and obturation of the root canal system. However, when dealing with complex anatomies, such as curved and narrow canals, the preparation process becomes significantly more challenging. These intricate canal systems are more susceptible to procedural complications, including lodging, zipping, and transportation errors. The present study was conducted on S-shape canal simulator endo-blocks to investigate the shaping results of Neoniti rotary system compared with Wave One Gold rotary system, where both of the groups were used with reciprocal motion. Our study results indicated that in the apical and middle third, transportation was less in the Neoniti group, although it was not statistically significant for the apical third. In the coronal third Neoniti demonstrated more transportation without statistical significance.

The major factors that can affect canal transportation are canal anatomy, instrument design, instrument alloy, and instrumentation

technique [7]. Angle and radius of the curvature are the anatomic factors that affect transportation. Severe curvatures with smaller radius are more likely to be transported [8-10]. Double curvature is also among the complex canal anatomies in terms of canal preparation [3]. Instruments with non-cutting tips would make less canal transportation [11]. Neoniti and WOG both have non-cutting tips, making them favorable systems in cases with severely or double curved canals. Both rotary systems have treated alloys with modified metallurgy leading to more flexibility and less probability of canal transportation [12,13]. Considering the instrumentation technique, one of the major factors is glide path preparation, which was considered in both groups. There is also available evidence supporting reciprocal motion over full rotation [14]. In the current investigation, Neoniti which is mainly used with full rotating motion, and WOG, a reciprocal system, were compared using reciprocal motion for both systems. Data suggested that Neoniti respected the curvature anatomy better than WOG.

Using canal simulator endo-blocks is an option to standardize research methodology and control confounding variables, which are the challenges when extracted teeth are used as study subjects [15,16]. It is difficult, if not impossible, to standardize extracted teeth in terms of canal curvature characteristics, canal cross-section, canal patency, etc. [17]. On the other hand, it is suggested that although low-hardness blocks may overestimate the transportation measures, high-hardness blocks are not different from extracted teeth in terms of canal transportation [18]. In the present study, endo-blocks were used to standardize the methodology. However, the hardness of the blocks were neither mentioned by the manufacturer, nor studied yet.

Although previous findings reported by Yoo and Cho [19] indicated that canal preparation with Wave One reciprocating system led to less canal transportation in the apical part of the canal in comparison with systems with continuous rotation [19]; recent studies have not shown the same results [20, 21]. The present study tried to use Neoniti rotary files, contradictory to the manufacturer's catalogue, with reciprocal motion. We observed even less transportation in the apical and middle thirds of the canal in Neoniti group compared with WOG, with no significant differences in the apical and coronal thirds. The results become even more intriguing when taking into account the findings of a prior research conducted by Vallabhaneni et. al. [26], which suggested that the WOG single reciprocation file maintained the original canal anatomy more effectively than the Neoniti single continuous file. Some authors have suggested that the increased transportation associated with the WOG system is due to its pecking motion rather than a brushing motion. However, the data indicates that the Neoniti group achieved superior results compared to WOG, despite both systems being used with a pecking motion. This finding highlights the efficacy of the Neoniti system in maintaining canal integrity during preparation

Although Neoniti system had previously proved to result in less canal deviation as well as shorter instrumentation time compared with ProTaper Universal [22], shaping with this system with reciprocal motion resulted in even less canal transportation.

The baseline diameter of the canal in blocks was 0.2 mm. The rationale for using these blocks was the necessity of canal enlargement up to #20 hand file before using rotary instruments [23]. Considering that the canal diameter is generally smaller, one could infer that the volume of transportation may exceed the results obtained in the current study when adjusted for actual canal dimensions.

The fact that the only significant difference in transportation was observed in the middle third, considering that in the studied blocks the curve was mainly present in the middle third of the simulated canal, may indicate that Neoniti respects the curve anatomy significantly more than WOG, when used with reciprocal motion. Coronal third transportation, which was not different among the groups, is critical due to the possibility of strip

perforation, esp. when dentinal wall of the danger zone is thin. Coronal transportation was slightly more in Neoniti group. Although the apical transportation was not statistically different among groups, less apical transportation was observed when the blocks were prepared with Neoniti system. Apical transportation has the potential to jeopardize the integrity of the apical seal during obturation, posing a significant risk to the overall success of the treatment. [24].

CONCLUSION

While initially introduced as a rotary instrument intended for continuous rotation, the Neoniti system can also be effectively utilized with reciprocal motion, yielding satisfactory results. Our findings suggest that this rotary system may better preserve canal anatomy compared to reciprocal motion-based instruments like WOG. This indicates the potential advantages of Neoniti in maintaining the integrity of complex canal systems during endodontic procedures.

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CONFLICT OF INTEREST STATEMENT

None declared.

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