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Original Article

Comparative Evaluation of Canal Transportation and Centering Ability of TruNatomy and MicroMega One RECI in Curved Root Canals

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CLINICAL SIGNIFICANCE

This study underscores the need for dentists to consider the unique anatomical and clinical needs of each case when selecting an endodontic file system.

ABSTRACT

Objectives: To compare the canal transportation and centering ability of two different file systems, TruNatomy (TRN) and MicroMega One RECI (MMOR), in curved root canals.

Materials and Methods: Forty upper premolars with root canal curvatures ranging from 25° to 40° were divided into two groups (n=20): Group A, instrumented with TRN file system in continuous rotation motion, and Group B, instrumented with the MMOR file system in reciprocating motion. Pre- and post-instrumentation CBCT scans were taken using the Kodak Carestream CS 9300 machine to analyze canal transportation and centering ability at different canal levels (2mm, 5mm, 8mm). Data analysis was conducted using a student t-test for comparison between the groups.

Results: The study demonstrated that the MMOR system significantly reduced canal transportation at 5mm and 8mm levels in the mesiodistal plane compared to the TRN system ($p<0.05$). In the buccolingual plane, significant differences were noted only at 8mm. For centering ability, MMOR showed superior performance at 5mm and 8mm in the mesiodistal plane ($p<0.05$), whereas TRN was better at 2mm ($p<0.05$). No significant differences were observed in the buccolingual plane at 5mm and 8mm levels. These findings highlight the distinct advantages of each system in specific clinical contexts.

Conclusion: While both systems are clinically effective, their selection should be tailored to the specific requirements of each case. The MMOR system may be preferable in scenarios where minimal canal transportation and precise centering are paramount. In contrast, the TRN system is a viable option in cases requiring strong apical centering ability.

1. Introduction

Root canal therapy necessitates accurate and efficient shaping of the canal to ensure successful treatment outcomes. Recent advancements in endodontics have led to the development of numerous novel instrumentation systems, each promising enhanced shaping capabilities and procedural safety by minimizing common errors such as ledges, perforations, and excessive thinning of canal walls.[1] The effectiveness of such systems is typically assessed through a variety of metrics derived from micro-computed tomographic scans. These metrics provide insights into how each system impacts the spatial characteristics within the root canal at various levels, thereby influencing the treatment outcomes.[2-4]

Two such contemporary instrumentation systems are the TruNatomy (TRN [Dentsply Sirona, York, PA]) and MicroMega One RECI (MMOR [Micro-Mega, Besançon, France]). Each of these systems boasts unique properties due to their specific geometric designs, metallurgical makeup, and kinematic characteristics.[5,6]

The TRN system is a rotary file system composed of superelastic nickel-titanium (NiTi) wires. The system's innovative heat treatment process reduces memory and enhances its superelastic properties, thus supporting improved canal shaping with minimal risk of procedural errors. TRN's distinguishing features such as its regressive tapers and slim design contribute to its reported superior fatigue resistance in comparison to other systems.[4,7]

On the other hand, the MMOR system is a reciprocating single-file system, featuring a unique metallurgical treatment that enhances the flexibility of the instrument while reducing its memory. MMOR's instrument design includes a progressive taper and an offset mass of rotation, which claim to increase the instrument's efficiency while reducing the risk of canal transportation and file separation. The system's shaping ability, particularly in curved or complex canals, has been subject to several studies, highlighting its effectiveness in maintaining original canal anatomy.[5,8]

The primary aim of this study is to evaluate and compare the canal transportation and centering ability of the TRN and MMOR systems in curved root canals. The null hypotheses tested were that there would be no difference in canal transportation and centering ability in curved root canals amongst these instrumentation systems.

2. Materials and Methods

2.1. Sample Selection and Preparation

This study was approved by the institutional ethics committee of Oman Dental College (ref no. 2023-AJ-19Y). The selected sample size was 40 human mandibular premolars, each with a single canal and a curvature greater than 25° but less then 40°, as determined by Schneider's method.[9] In this method, x-rays of the teeth were taken in both the buccolingual and mesiodistal planes. On the x-ray, a line was drawn parallel to the canal's long axis. A second line was drawn from the apical foramen to intersect the first at the point where the canal started to leave the tooth's long axis. The acute angle formed was measured with SIDEXIS XG software's "Measure angle" function (Sirona Dental Systems GmbH, Bensheim, Germany).

The teeth were stored in saline, and each tooth was standardized at a length of 15 mm. Following this, the teeth were arranged in a template and scanned using a Kodak Carestream CS 9300 CBCT machine (Carestream Dent LLC, Atlanta, G, USA).

2.2. Root Canal Preparation

Subsequently, the teeth were randomly assigned into one of two experimental groups (Group A and Group B), each containing 20 teeth. In Group A, root canal preparation was executed using a TruNatomy file (Dentsply Sirona, Germany) with continuous rotation motion, whereas Group B utilized a MicroMega One RECI file (Micro-Mega SA, Besancon, France) with reciprocating motion. A single operator, previously trained in both methods, performed all the instrumentation.

2.3. Assessment of Root Canal Preparation

The parameters for assessing the root canal preparation were based on the formula provided by Gambill et al.[10] The degree of canal transportation was calculated using the formula ($[a_1-a_2]-[b_1-b_2]$), with a_1 and a_2 representing the shortest distance from the mesial edge of the root to the mesial edge of the uninstrumented and instrumented canal, respectively. Similarly, b_1 and b_2 represent the distance from the distal edge of the root to the distal edge of the uninstrumented canal and instrumented canal, respectively. A result of "0" indicates no canal transportation while any other number indicates that transportation has occurred. The centering ability was calculated using the formula $(a_1-a_2)/(b_1-b_2)$ or $(b_1-b_2)/(a_1-a_2)$, depending on which number was lower, the lower figure was considered as the numerator. A result of "1" indicates perfect centering (Fig. 1). Figure 2 displays superimposed pre- and post-operative CBCT scans, illustrating the changes in canal morphology resulting from the use of the TRN and MMOR systems.

2.4. Statistical Analysis

Statistical analysis was conducted using the student t-test for inter-group comparisons at different measurement distances from the apex. This included evaluating canal transportation and centering ability for both the TRN and MMOR systems in buccolingual and mesiodistal planes. The t-test was utilized to identify significant differences in performance between the two systems at the specified distances of 2mm, 5mm, and 8mm from the apex. The threshold for statistical significance was set at 0.05. This analysis method provided a clear comparison of the two endodontic systems' effectiveness in canal shaping and their respective impacts on canal transportation and centering ability. All analyses were performed utilizing R software (4.3.2). The assumption of normality was checked based on the Shapiro-Wilk test (α=0.05). The test priori power is strong (0.9178).

3. Results

Throughout the study, there were no incidents of instrument separation during the procedures.

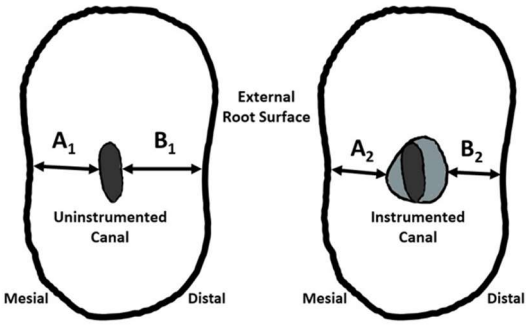

Fig. 2. Comparative CBCT imaging of canal morphology: superimposed scans pre- and post-instrumentation, highlighting the impact of two different endodontic rotary systems on canal morphology.

Table 1 showcases the mean values and standard deviations for canal transportation. The table also includes p-values from Student t-tests, comparing the TRN and MMOR systems at different distances from the apex in both buccolingual and mesiodistal planes. In the mesiodistal plane, at distances of 5mm and 8mm from the apex, the MMOR system demonstrated a lesser amount of canal transportation that was significantly different compared to the TRN system ($p < 0.05$). At a depth of 2mm from the apex in the mesiodistal plane, however, no significant differences in canal transportation were observed between the two systems ($p > 0.05$). In the buccolingual plane, a significant difference favoring the MMOR system was noted only at the 8mm level, while at the 2mm and 5mm levels, the differences were not statistically significant ($p > 0.05$).

Table 2 demonstrates the means and standard deviations for centering ability. At the 5mm and 8mm levels in the mesiodistal plane, the MMOR system displayed significantly better centering ability compared to the TRN system ($p < 0.05$). Conversely, at the 2mm level in the same plane, the TRN system showed superior centering ability, with the difference being statistically significant ($p < 0.05$). In the buccolingual plane, a significant difference was observed only at the 2mm level, favoring the TRN system ($p < 0.05$). At the 5mm and 8mm levels in the buccolingual plane, no statistically significant differences were noted ($p > 0.05$).

4. Discussion

The MMOR system is considered to be one of the newest systems introduced in the field and has been mentioned only four times in the existing literature. One study investigated the Effect of Different Endodontic Access Cavities on Instrumentation

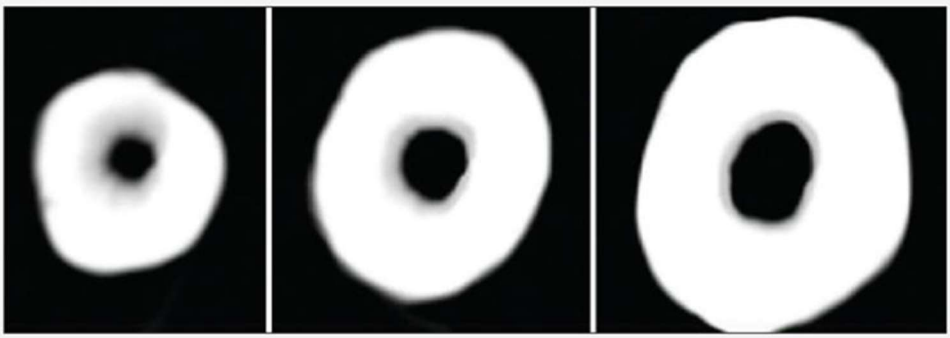

Fig. 1. Illustrative representation of tooth sections indicating the derivation of transportation, centering ratios, and remaining dentin thickness measurements. The uninstrumented image (on the left) depicts the original canal space as highlighted by the darker shade. The instrumented image (on the right) showcases the canal's contour post-instrumentation, indicated by the lighter shade.

Table 1. Mean and Standard Deviation of Canal Transportation (mm from apex) for TruNatomy and One RECI Systems at 2mm, 5mm, and 8mm distances

		TruNatomy	One RECI	p-value
Buccolingual	2mm	0.054±0.012	0.069±0.031	0.051
	5mm	0.075±0.010	0.080±0.008	0.089
	8mm	0.087±0.009	0.067±0.011	**<0.001**
Mesiodistal	2mm	0.049±0.008	0.053±0.009	0.146
	5mm	0.136±0.026	0.021±0.010	**<0.001**
	8mm	0.156±0.011	0.037±0.011	**<0.001**

Table 2. Mean and Standard Deviation of Centering Ability (mm from apex) for TruNatomy and One RECI Systems at 2mm, 5mm, and 8mm distances

		TruNatomy	One RECI	p-value
Buccolingual	2mm	0.644±0.018	0.604±0.028	**<0.001**
	5mm	0.571±0.010	0.568±0.020	0.552
	8mm	0.542±0.034	0.521±0.046	0.109
Mesiodistal	2mm	0.620±0.027	0.586±0.050	**0.011**
	5mm	0.379±0.031	0.822±0.040	**<0.001**
	8mm	0.345±0.047	0.728±0.052	**<0.001**

Efficacy;[11] another assessed the Cyclic Fatigue Resistance of Reciprocating versus Continuous Rotating Nickel-Titanium Instruments and found that MMOR exhibited suitable mechanical properties with the highest cyclic fatigue resistance and angle of rotation among other instruments tested;[8] a third study measured the Apically Extruded Debris in Curved Root Canals and revealed that the MMOR system produced statistically lower apically extruded debris than other systems;[5] and the fourth was a narrative review that touched on this newly introduced system.[6] These studies underline the burgeoning interest in and early successes of the MMOR system, while also emphasizing the need for further research to fully understand its range of applications and potential advantages. To our knowledge, this work represents the first investigation into the centering ability and canal transportation of the MMOR system, providing essential insights into these critical aspects of this new endodontic file system.

The outcomes of the current study reveal notable differences in canal shaping between the TRN rotary system and the MMOR system. Their impacts on canal transportation and centering ability in this study were distinct, despite both systems being engineered for efficient root canal shaping.

This study highlighted that the MMOR system resulted in less canal transportation at both the coronal and middle levels in the mesiodistal plane, and at the coronal level in the buccolingual plane. It also demonstrated superior centering ability at these levels. Conversely, the TRN system exhibited notably good apical centering ability, particularly at the apical level, showing significant superiority over MMOR. This could be attributed to its unique design features, such as off-center cross-sections and progressive tapering at the apical section.[6] Interestingly, the TRN system showed better performance apically, while the MMOR system excelled in the middle and coronal thirds of the canal. These observations align with previous research that has emphasized the strong performance of the TRN system, especially in the apical third of the canal.[12]

Despite the TRN system's well-documented efficacy in past research,[4,12,13] our current investigation indicates that it was outperformed by the MMOR system in certain respects. This outcome could potentially be attributed to the system's reciprocating motion, which may lead to a lower degree of canal transportation compared to rotary systems. In addition, the variable and asymmetrical section of the MMOR system might enhance cutting efficiency and debris clearance, potentially facilitating better canal centering during the procedure.[6,14]

The findings of this study can be considered clinically relevant. Past research suggests that canal transportation less than 0.3 mm would have a minimal impact on the treatment prognosis.15 All canal transportations in this study were below this threshold, thus underscoring the clinical efficacy of both systems. However, the differences observed between the two systems, particularly at the coronal and middle levels where MMOR demonstrated advantages, and at the apical level where TRN excelled, suggest that the selection of the endodontic file system should be tailored to the specific requirements of each case. Dentists are encouraged to consider these findings when selecting a system, ensuring that their choice aligns with the unique anatomical and clinical needs of each individual treatment scenario.

While our study provides valuable insights into canal transportation and centering ability for the TRN and MMOR rotary systems, it is important to consider certain limitations. Firstly, the use of extracted teeth and simulated clinical settings, though offering a controlled environment for in vitro studies, cannot perfectly replicate the complex and varied morphology of teeth encountered in live patients. In vitro models offer enhanced standardization compared to clinical settings, but they lack the ability to fully mimic the diversity and nuances of dental anatomy found in natural clinical scenarios.

Furthermore, the employment of CBCT in our study, as opposed to Micro-CT, represents another limitation. CBCT, while practical and widely used in dental research, does not provide the high resolution and detailed imaging capabilities of Micro-CT. This difference in imaging resolution could potentially influence the accuracy of our measurements, particularly in assessing fine details related to canal transportation and centering ability. Consequently, these factors should be taken into consideration when interpreting the findings of our study. Future studies, ideally incorporating randomized clinical trials, are required to reinforce and broaden these findings. Additionally, considering parameters such as working time, user-friendliness, and cost-effectiveness will facilitate a more comprehensive evaluation of these systems in real-world clinical settings.

5. Conclusion

This study provides an important evaluation of the TRN and MMOR systems, two innovative endodontic file systems. While the TRN system has been well-documented in previous research for its efficiency, particularly in the apical third of the canal, our investigation revealed that the MMOR system, though relatively new and less extensively studied, demonstrates notable advantages in certain aspects of canal shaping.

Our findings indicate that the MMOR system caused less canal transportation and showed superior centering ability at the coronal and middle levels in the mesiodistal plane, and at the coronal level in the buccolingual plane. In contrast, the TRN system exhibited strong apical centering ability, particularly at the apical level.

The clinical relevance of these results is underscored by the fact that all measured canal transportations were below the threshold that might impact treatment prognosis, emphasizing the clinical efficacy of both systems. However, the distinct differences between the two systems, especially in the middle and coronal thirds favoring MMOR, and at the apical level favoring TRN, highlight the importance of system selection based on the specific requirements of each case.

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CRediT Author Statement

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Conflict of Interest

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