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Comparative Analysis of Root Canal Geometry Alterations Created by Three Rotary Ni-Ti Systems: A CBCT Investigation

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KEYWORDS

endodontic therapy, canal transportations, rotary files, CBCT, root canal therapy, mandibular molars.

ABSTRACT:

Aim: Comparison of shaping ability of three rotary Ni-Ti systems: Orodeka, Gen Endo, and Mani Jizai in the mandibular molars using cone-beam computed tomography (CBCT).

Materials and method: This prospective in-vivo investigation comprised 45 mandibular molars with curvatures ranging from 20° to 40°. Teeth were randomly assigned to three groups (n = 15) based on the rotational system: Orodeka, Gen Endo, and Mani Jizai. Standardised access cavity preparation, glide route construction, & biomechanical preparation were carried out in accordance with manufacturer specifications. Pre and Post instrumentation CBCT scans were acquired. Using the Gambill et al. formula, canal transportation was estimated at 3 mm, 8 mm, & 15 mm from the root apex respectively. Data was analysed using one-way ANOVA & post-hoc testing.

Discussion: Satistically significant difference was noted at 3 mm in canal transportation amongst the three systems ($p = 0.04$); Orodeka with least transportation. There were no statistically significant changes between the 8- and 15-mm levels ($p > 0.05$). Intergroup study found substantial changes at the intermediate as well as apical levels, while intragroup comparisons revealed no clinically meaningful variation between canal levels within any system.

Conclusion: All three rotational Ni-Ti systems showed effective and predictable shaping, with minimum canal transportation and good centring. The results indicate that Orodeka, Gen Endo, & Mani Jizai are safe and appropriate for regular endodontic instrumentation of mandibular molars.

1. Introduction

Root canal preparation is a fundamental step in endodontic treatment, focused on thorough cleaning and shaping of the root canal system while preserving its original anatomical configuration. However, the complicated architecture of mandibular molars, especially in mesial roots, presents a significant obstacle.1 The curvature of these canals frequently predisposes them to procedural mistakes such as canal transfer, ledge creation, and excessive dentin removal, which might jeopardise anticipated durability and clinical success of Root canal treated teeth over an extended period.2

Rotary nickel-titanium (NiTi) instrumentation devices outperform stainless-steel files in curved canals, demonstrating improved flexibility and efficiency. The differences in file design, metallurgy, & taper affect their capacity to preserve canal curvature and dentinal structure.3 Excessive dentin removal, particularly in the pericervical area, weakens root structure and increases the risk of vertical root fractures, thereby rendering dentin preservation an absolute clinical priority.4

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The introduction of improved heat-treated NiTi systems has increased flexibility and fatigue resistance, enabling more secure and conservative canal preparation. Orodeka, Gen Endo, and Mani Jizai systems use various cross-sectional geometries, metallurgical treatments, & kinematics, all of which might impact their shaping behaviour.5 Comparative study of such systems in vivo gives vital information into their clinical performance under actual biomechanical settings, as opposed to in vitro.3

Cone-beam computed tomography (CBCT) is a dependable imaging method for accurately evaluating root canal shape along with influencing results. Unlike two-dimensional radiography, CBCT can examine canal transit, centring ability, & dentinal thickness at different locations along the root canal in three dimensions.6Literature suggests various studies done in-vitro to assess the above parameters. Hence to bridge this gap, we accept to an in vivo CBCT-based comparative analysis of modern rotary systems offers a clinically relevant understanding of their shaping ability and their ability to preserve peri-cervical dentin.

2. Objectives:

To evaluate and compare the canal transportation of Orodeka, Mani Jizai and Genendo rotary Niti instrument

3. Method

Study Design: Prospective, in vivo comparative study was conducted on patients requiring endodontic treatment in mandibular molars which compared the shaping ability of 3 rotary NiTi systems using cone-beam computed tomography (CBCT).

Ethical Approval: The study protocol was approvrd from the Institutional Ethics Committee before the commencement of the study (NPDCH/IEC/2024/209). Informed written consent was obtained from all participating patients.

Sample Selection: 45 patients were included in the prospective comparative study who were undergoing RCT on mandibular molars with fully formed apices and curvatures ranging between 20–40. Teeth exhibiting external or internal resorption, previous endodontic treatment, calcified canals, or root fractures teeth were excluded.

Access Opening and Glide Path Preparation: Following local anesthesia and isolation with a rubber dam, conventional access cavity was prepared and working length was established using electronic apex locator and subsequently verified with radiograph. A glide path was prepared using 10# and 15# K-files.

Group Allocation: The cases were randomly allocated into three groups (n = 15 each) for biomechanical preparation:

Group A :- Orodeka rotary file system

Group B :- Gen Endo rotary file system

Group C :- Mani Jizai rotary file system

Canal Preparation Protocol: Biomechanical preparation was carried out in accordance with the manufacturer's guidelines for each rotary system, using endodontic motor with recommended torque and speed. Intermittent irrigation with 3% sodium hypochlorite, followed by 17% EDTA, and completed with final rinse of normal saline.

CBCT Imaging Protocol: CBCT scans were taken pre and post-instrumentation using same machine and exposure settings to ensure uniformity. Standardized cross-sectional images were acquire at 3 mm, 8 mm, and 15 mm from the apex to evaluate Canal transportation

Outcome Assessment: Canal transportation was computed using the algorithm described by Gambill et al.7

Canal transportation = $(m_1 - m_2) - (d_1 - d_2)$

Where,

m1 = distance between mesial border of root and mesial margin of uninstrumented canal.

m2 = distance between mesial border of root and mesial margin of instrumented canal

d1 = distance between distal border of root and distal margin of uninstrumented canal

d2 = distance between distal border of root and distal margin of instrumented canal

Statistical Analysis: All quantitative measurements obtained from CBCT were carefully recorded and

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compiled for statistical analysis. Data were analyzed using Statistical Package for Social Sciences (SPSS), version 20. Descriptive statistics, including mean and standard deviation, were calculated for each variable. Intergroup comparisons among different rotary Ni-Ti systems were carried out using one-way analysis of variance (ANOVA). In instances where ANOVA showed significance, post-hoc multiple comparison tests were applied to identify specific pairwise differences. A p-value of less than 0.05 was considered statistically significant.

4. Results

The results was tabulated for 45 mandibular molar teeth where the canal transportation was being measured at 3mm, 8mm and 15 mm using 3 different files (Orodeka, Mani Jizai and Genendo)

Table 1: Canal transportation at 3mm, 8mm and 15 mm using 3 different Ni-Ti rotary files.

Distance	Groups	No.	Value		P Value
			Mean	SD	
3mm	Orodeka	15	0.0014	0.0130	0.04*
	Mani Jizai	15	0.0507	0.1874	
	Genendo	15	0.1092	0.3520	
8mm	Orodeka	15	0.00147	0.01477	0.060**
	Mani Jizai	15	0.00240	0.01479	
	Genendo	15	-0.01287	0.02562	
15mm	Orodeka	15	-0.00340	0.02032	0.679**
	Mani Jizai	15	-0.00273	0.02048	
	Genendo	15	0.00227	0.01649	

Level of Significance P ≤ 0.05, * Significant, ** Non-Significant

At the 3 mm level, statistically significant difference was noted in canal transportation amongst the three rotational systems (p = 0.04); Orodeka with least transportation compared to Mani Jizai and Genendo. At the 8 mm and 15 mm levels, significant differences was not noted between the groups (p > 0.05), showing that all three systems performed similarly in the middle & apical thirds of the canal.

At the 3 mm level, no significant variations in canal transit were found between the Orodeka, Mani Jizai, and Genendo instruments (p > 0.05). At the 8 mm level, there was a significant difference between Orodeka & Mani Jizai (p = 0.034), while comparisons with Genendo were not statistically significant. At the 15 mm level, significant differences was noted between Orodeka and Mani Jizai (p = 0.05) and Orodeka and Genendo (p = 0.012), showing variance in apical shaping behaviour, but Mani Jizai and Genendo performed similarly (p > 0.05).

Table 2: Comparison of canal transportation with at 3 mm, 8 mm, and 15 mm levels

Distance	Groups		P Value
3mm	Orodeka	Mani Jizai	0.829**
		Genendo	0.413**
	Mani Jizai	Genendo	0.767**
8mm	Orodeka	Mani Jizai	0.034*
		Genendo	0.112**
	Mani Jizai	Genendo	0.085**
15mm	Orodeka	Mani Jizai	0.05*
		Genendo	0.012*
	Mani Jizai	Genendo	0.757**

Level of Significance P ≤ 0.05, * Significant, ** Non-Significant

Table 3: Intragroup Comparison of Canal Transportation

Groups	Distance	No.	Value		P Value
			Mean	SD	
Orodeka	3mm	15	0.0014	0.01301	0.048*
	8mm	15	0.0014	0.01477	
	15mm	15	-0.0034	0.02011	
Mani Jizai	3mm	15	0.0507	0.18741	0.313**
	8mm	15	0.0024	0.01479	
	15mm	15	-0.0027	0.02048	
Genendo	3mm	15	0.1092	0.35206	0.224**
	8mm	15	-0.0128	0.02562	
	15mm	15	0.0022	0.01649	

Level of Significance P ≤ 0.05, * Significant, ** Non Significant

The intragroup comparison showed no significant variation in canal transportation across the three tested levels (3 mm, 8 mm, and 15 mm) within any of the

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rotational systems. Although Orodeka showed a slightly significant variance ($p = 0.048$), the Orodeka, Mani Jizai, & Genendo instruments all exhibited similar shaping behaviour over the canal length, demonstrating stable canal centring and little transportation within each group.

5. Discussion

Canal centering capacity in RCT is ability of endodontic file to remain in the original canal path, preventing canal transportation, which is crucial for preventing root anatomy, especially in curved canals. Material and design of file, taper, cross-section, Glidepath and motion of the file influences the Canal transportation.

Most modern NiTi system are observed to perform adequately including reciprocating and rotary system which is evidenced by various in-vitro studies conducted. Hence, the study attempted to assess the in-vivo shaping ability of 3 rotary systems- Orodeka, GenEndo and Mani Jizai systems.

Jizai is a newly designed NiTi rotary file system manufactured of proprietary heat-treated NiTi alloy. Jizai has an off-center quasi-rectangular cross-section with a radial land on one of the short sides where manufacturers claim that it creates low screw-in forces and offers ample space for effective debris elimination while preserving the canal's centering capability..7

Trunatomy (TRN; dentsply sirona, maillefer, ballaigues, switzerland) is a novel heat-treated niti system with three shaping files. The shaping files offer a slim NiTi wire design combined with maximum flute diameter, variable taper, and off centered cross-section.

The new Genendo™ heat-treated nickel–titanium rotary files, developed by Micro-Mega and specially manufactured for Coltene India, are designed to offer an optimal balance of flexibility and strength. The triple-helix cutting edge facilitates circumferential debris removal, while the helical angulation of the cutting edges minimizes the risk of the file screwing into the canal.8

The current study examined canal transportation at the coronal (15 mm), intermediate (8 mm), & apical (3 mm) levels utilising three different Ni-Ti rotary systems: Orodeka, Mani Jizai, and Genendo. Canal transportation is an important feature in endodontic instrumentation because severe departure from the natural canal curvature can reduce cleaning efficiency and impair root integrity. At the 3 mm level, there was a statistically significant difference between the three systems, with Orodeka showing the least transportation.9 This shows improved coronal canal centring, which might be associated to the alloy's elasticity, cross-sectional design, as well as taper structure. Similar findings were reported by Peters & Paqué, who emphasised that greater flexibility and regulated taper minimise coronal transportation while preserving dentin integrity.10

At the 8 mm and 15 mm levels, no statistically significant differences were noted between the three methods, showing equivalent shaping performance in the middle and apical thirds. These findings are similar with previous research by Gergi et al. and Schäfer et al., who found that modern Ni-Ti rotary systems yield limited apical transportation because of superior metallurgy and design.11,12 Although intergroup comparisons indicated isolated significant differences at 8 and 15 mm, notably in Orodeka, these changes were modest and unlikely to be clinically meaningful.8

Intragroup analysis demonstrated no statistically significant difference in canal transportation at the three evaluated levels for any of the systems, suggesting consistent shaping performance throughout the length of the canal. This stability shows that all evaluated devices efficiently retained original canal architecture, which supports the findings of Bürklein and Schäfer, who demonstrated predicted canal centring using current rotational tools.12,13 Overall, the Orodeka, Mani Jizai, and Genendo systems are clinically satisfactory, resulting in minimum canal transportation and retaining canal curvature, indicating their safe usage in everyday endodontic therapy.13

6. Conclusion

The CBCT-based evaluation revealed that all three rotational Ni-Ti systems had efficient and predictable shaping capabilities in mandibular molars. The coronal, middle, & apical thirds showed minimal canal transportation and excellent canal centring, indicating that the original canal morphology had been preserved. Although modest deviations observed at some levels,

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they were minimal and not clinically significant. Overall, the data indicate that all three rotary Ni-Ti systems are safe, efficient, and suitable for regular endodontic instrumentation when utilised in accordance with accepted clinical guidelines.

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