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Comparative Evaluation Of The Obturating Quality Of Three Different Endodontic Rotary File Systems Using Cbct – An In-Vitro Study

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ABSTRACT

Introduction: Efficient cleaning or shaping of root canal system are vital for successful endodontic treatment, ensuring optimal obturation and minimizing microleakage. Aims & Objectives: This in vitro research aims to compare quality of obturation by utilizing 3 rotary file systems—**Coltene Gen Z**, **ProTaper Next**, **Neo Endo S**—with CBCT (cone-beam computed tomography) analysis. Materials & Methodology: Forty-eight extracted single-rooted mandibular premolars have been separated into 3 groups (n=16) and instrumented using the respective file systems with an XPEDENT endomotor. Irrigation has been conducted by utilizing 5.25 percent sodium hypochlorite as well as 17 percent EDTA. Canals have been obturated with AH Plus sealer or gutta-percha using lentulospirals and hand pluggers. Result: Obturation quality was assessed using RVG and CBCT, and data were analyzed using SPSS v17.0. **Results** showed **ProTaper Next** had highest percentage of acceptable obturation (87.5 percent) or density (93.75%), followed by **Coltene Gen Z** (62.5%) and **Neo Endo S** (50%). **Conclusion:** ProTaper Next demonstrated superior shaping and obturation efficacy compared to Coltene Gen Z, Neo Endo S, indicating its clinical advantage in endodontic procedures.

1. INTRODUCTION

Successful "endodontic treatment is achieved through thorough cleaning or shaping of root canal system, while" preserving original canal anatomy to facilitate proper obturation[1]. Schilder, in 1974, described canal shaping as an extension of coronal cavity preparation principles throughout root canal system[2]. Maintaining natural curvature of canal is crucial, as mechanical instrumentation can lead to canal straightening and deviations, compromising treatment outcomes[2,3].

The primary aim of obturation is to establish hermetic seal following chemomechanical preparation, preventing reinfection and promoting periapical healing[3]. A well-executed obturation should eliminate voids to minimize microleakage, which is critical in avoiding bacterial proliferation and potential retreatment.[4,5] Voids—especially in apical and coronal thirds—can result to leakage, reinfection, and treatment failure.[4,5,6]

Nickel–titanium (NiTi) rotary instruments, introduced by Walia et al. in 1988, revolutionized endodontics by improving efficiency, preserving canal curvature, and reducing procedural errors.[6] Several rotary systems have since been developed, varying in design, tip geometry, taper, and motion[7]. Among obturation techniques, the single cone method has gained popularity due to its simplicity and efficiency, provided the cone closely matches the prepared canal's taper.[7,8,9] However, mismatches between cone and canal shape may result in inadequate obturation.[9]

Rotary instrumentation often causes greater apical enlargement, which may affect obturation quality in techniques like lateral compaction, particularly near the apex.[10] Imaging modalities involving CBCT (cone-beam computed tomography) have become essential in endodontic diagnosis and research due to their non-destructive, 3D imaging capabilities.[11,12] CBCT offers greater sensitivity and accuracy compared to conventional radiography, making it ideal for evaluating obturation

quality.[13] However, artifacts from dense materials can affect CBCT interpretation.[13,14] Parameters like field of view (FOV), tube current (mA), and voltage (kVp) must be optimized to reduce volumetric distortion.[15]

NiTi rotary systems have demonstrated superior shaping ability and reduced procedural errors over stainless steel hand files.[16] Still, leakage may occur due to sealer shrinkage or voids, stressing the importance of matching cones and minimizing sealer volume.[16,17,18] AH Plus sealer is preferred for its low solubility and reliable sealing.[19,20] Systems like Coltene Gen Endo, Neo Endo S, ProTaper Next offer matched-taper cones and advanced designs for improved outcomes.[21,22,23]

Aim and Objectives were to compare or assess quality of obturation and likelihood of microleakage using Coltene Gen Endo, ProTaper Next, Neo Endo S rotary file systems via CBCT imaging.

2. MATERIALS AND METHODS

Study Setting and Design

Study Area: NIMS Dental College, Jaipur, Department of Conservative Dentistry & Endodontics. Study Population: Human teeth removed in vitro. Study Design: In vitro comparative analysis. "Time frame: 2023–2025. Sample Size: forty-eight" permanent mandibular premolars that were excised and had a single root.

"Inclusion Criteria: Single-rooted permanent mandibular" premolars

Exclusion Criteria: teeth obstructed by root canals, severely broken or decaying teeth, teeth that have more than one canal, teeth that have pulp stones, dentinal cracks, or calcifications. Root resorption in teeth, either internal or external

Materials Used: 48 mandibular premolars with single roots were removed. Lentulospirals (Mani), XPEDENT endomotor, "Endo access bur (Dentsply Maillefer, Switzerland), ProTaper Next file system (Dentsply), Neo Endo S file system, Coltene Gen Z file" system, Air rotor handpiece, and hand pluggers (Buchanan). A "thirty-gauge side-vented irrigation needle, AH Plus root canal sealer, 25 percent "sodium hypochlorite (Zodenta Safe Plus, Neelkanth Healthcare Ltd.), 17% EDTA" (Dentsply Maillefer), gutta-percha points (Dentsply ISO color-coded 6 percent, Coltene GEN X, Neo Endo S), Paper points, CBCT scanner (Vatech AZ I 3D"), and RVG scanner (Carestream)

Statistical analysis software: SPSS version 17.0 (Chicago, SPSS Inc.)

3. METHODOLOGY

Sample Collection and Preparation:

Forty-eight mandibular premolars extracted for orthodontic purposes have been collected. Teeth with caries, restorations, resorption, and previous root canal treatment were excluded. To ensure homogeneity, samples with canal anomalies, root curvature, or calcifications have been also excluded. Tooth length have been standardized to 16 mm by flattening the occlusal surface using a diamond disk. After being carefully cleaned under running water, teeth have been submerged in 5.25 percent sodium hypochlorite for a whole day in order to get rid of organic debris. The samples have been thereafter kept for 15 days at 37 degrees Celsius and 95 percent humidity in regular saline.

Sample Size Calculation:

Formula Used: Standard calculation for comparative studies

Total Sample Size: 48 teeth (16 per group)

"Sampling Technique: Random sampling"

Source of Data:

"Department of Oral or Maxillofacial Surgery at NIMS Dental College & Hospital in Jaipur" is where the teeth were gathered. "In Department of Conservative Dentistry and Endodontics, intraoral radiographs were obtained. The Department of Oral Medicine and Radiology in Jaipur" performed CBCT scans.

Access and Working Length Determination:

Conventional access cavities have been prepared with an Endo access bur using high-speed air rotor handpiece. Up to the apex, a #15 K-file has been inserted. Working length has been determined radiographically using Ingle's method and calculated by subtracting 0.5 millimeters from radiographic length.

Canal Instrumentation and Grouping:

A glide path has been created with #15 K-file. 48 teeth have been then randomly separated into 3 groups (n = 16 each):

"Group 1 – Neo Endo S File System

Coronal flaring was done using an 8% taper file; apical enlargement up to size 25 (6% taper).

Group 2 – Coltene Gen Z File System

Coronal enlargement with CF file; apical enlargement up to FF2 (#25, 6% taper).

Group 3 – ProTaper Next File System

Coronal enlargement with XA file; apical enlargement with" X2 file (#25, 6% taper).

Each system has been utilized as per manufacturer's instructions up to working length, with coronal reference point standardized.

Irrigation Protocol:

- 2 milliliters of 5.25 percent NaOCl after every file
- "Smear layer removal with 17 percent EDTA, followed by NaOCl" rinse
- Final flush: 4 mL normal saline
- Canals dried with paper points

Obturation:

AH Plus sealer was applied using lentulospirals, or obturation has been done by utilizing single cone method with corresponding gutta-percha cones from each file system. Hand pluggers were used to ensure compaction.

Post-Operative Evaluation:

Post-obturation CBCT scans were taken for all samples using Vatech AZ I 3D. Evaluation was based on the Coll or Sadrian criteria:

"Underfilling – >2 mm short of apex in all canals

Optimal filling – At apex or" up to 2 mm short in any canal

Overfilling – Any material extrusion beyond apex

Voids – Presence or absence throughout the canal

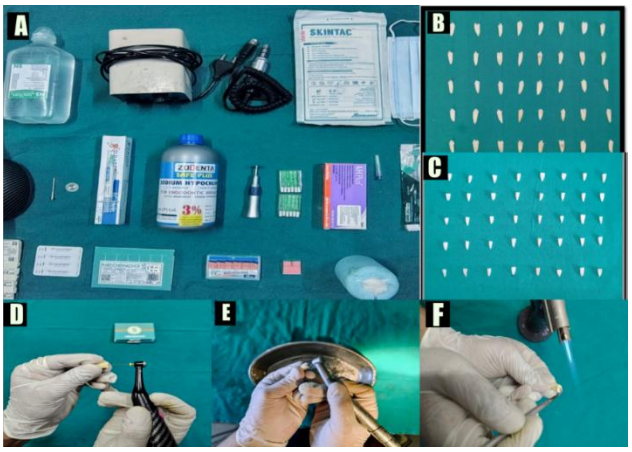


Fig. 1

4. RESULT

The current in-vitro research has been performed to evaluate or compare quality of obturation achieved using 3 rotary endodontic file systems—Coltene Gen Z, Neo Endo S, ProTaper Next—with help of CBCT. The length of obturation or density of obturation was assessed and classified as acceptable or unacceptable. Chi-square test has been utilized to examine data at significance level of 5 percent (p less than 0.05).

Length of Obturation

Table 1: Length of Obturation

Category	Neo Endo S File	Coltene Gen Z File	ProTaper Next File
Acceptable	6 (37.5%)	9 (56.25%)	14 (87.5%)
Not Acceptable	10 (62.5%)	7 (43.75%)	2 (12.5%)
Total	16	16	16

Acceptable: Gutta-percha is 0.5–2 mm “short of the apex

Unacceptable: Gutta-percha extends beyond the apex or is > 2 mm short

Chi-square Test Results: Chi-square value: 8.537

p-value: 0.01401

Interpretation:

Since p-value is” < 0.05, result is statistically significant. This shows significant difference in obturation length among three rotary file systems. ProTaper Next demonstrated highest rate of acceptable obturation length (87.5%), followed by Coltene Gen Z (56.25%), while Neo Endo S showed lowest (37.5 percent).

Density of Obturation

Table 2: Density of Obturation

Category	Neo Endo S File	Coltene Gen Z File	ProTaper Next File
Acceptable	8 (50%)	10 (62.5%)	15 (93.75%)
Not Acceptable	8 (50%)	6 (37.5%)	1 (6.25%)
Total	16	16	16

Acceptable: Absence of voids

“Unacceptable: Presence of voids in any section

Chi-square Test Results: Chi-square value: 7.564

p-value: 0.02278”

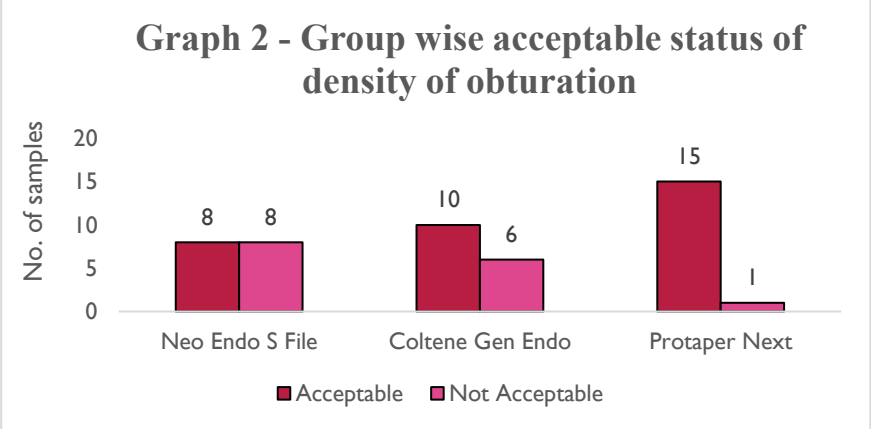
Interpretation:

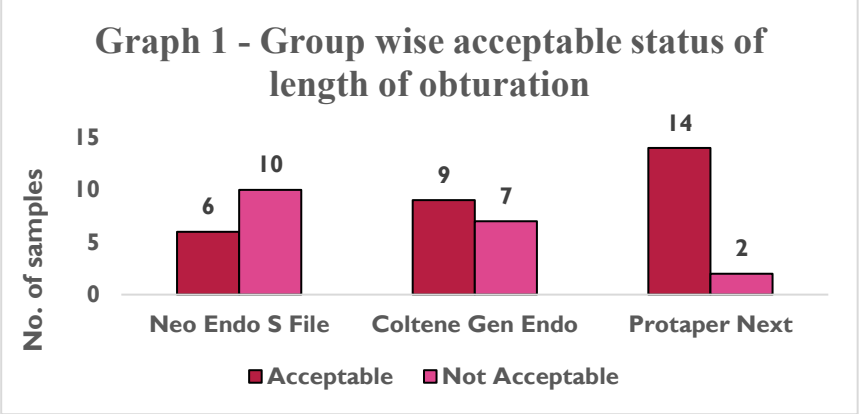
Outcome is statistically significant (p <0.05), indicating that density of obturation differs significantly among three systems. ProTaper Next exhibited highest rate of void-free obturation (93.75%), followed by Coltene Gen Z (62.5%) and Neo Endo S (50%).

Graphical Representation:

Graph 1: Group-wise distribution of acceptable vs. unacceptable length of obturation

Graph 2: Group-wise distribution of acceptable vs. unacceptable density of obturation





5. DISCUSSION

3D obturation of root canal system is essential in achieving a fluid-tight seal that blocks microbial ingress and prevents secondary infection. Inadequate obturation—whether due to underfilling, overfilling, or the presence of voids—remains a principal cause of endodontic treatment failure. Thus, obturation quality is a key determinant of long-term success in endodontic therapy.

Yu Hong Liang emphasized that root canal fillings should ideally terminate within 0 to 2 millimeters of radiographic apex and be void-free to optimize periapical healing and treatment outcomes. Proper canal shaping and debridement are prerequisites to this goal. Schilder's principles dictate that canals should be prepared to a continuously tapered form, narrowest at the apex and widest coronally, without ledges, zips, or other procedural deviations.[22,23,24]

In the present research, a standardized working length of 16 millimeters was used. To decrease inter-operator variability, single operator prepared each canal by utilizing crown-down method. Rotary systems utilized included ProTaper Next, Neo Endo S, and GenENDO, each with distinct design features and shaping characteristics.

Instrumentation Systems and Shaping Characteristics:

ProTaper Next, manufactured using "M-Wire NiTi alloy, has an off-centered rectangular cross-section" that provides asymmetric rotation, enhancing file strength or "cyclic fatigue resistance.[15] This allows file to" engage canal walls at only two points, improving shaping while minimizing stress. The system's "X1 (17/0.04), X2 (25/0.06) files" have been utilized, and their alternating taper enhances irrigation and obturation effectiveness. According to "Johnson et al. (2008), M-Wire" can outperform traditional NiTi in terms of resistance to cyclic fatigue by up to 400%.[24]

GenENDO offers a simplified file sequence comprising CF (Coronal Flare), Preparation File (PF), GPF (Glide Path File), Universal Finishing File (UFI), with optional finishing files (FF2, FF3). With speeds of 400 rate per annum or torque values of 1.8 to 2.5 Ncm, this system is designed for efficient cleaning and shaping. Though promising, its obturation quality was intermediate compared to ProTaper Next.. [22]

Neo Endo S files are made of heat-treated NiTi, offering flexibility and fracture resistance. The S-shaped cross-section reduces radial wall contact, allowing better debris removal, and the non-cutting tip minimizes ledging and apical extrusion.[23] However, this system showed the lowest percentage of optimal obturation outcomes, possibly due to limitations in shaping or cone adaptation.

Irrigation and Obturation Protocol:

Instrumentation was complemented with irrigation by utilizing 5.25 percent sodium hypochlorite, 17 percent EDTA, normal saline to disinfect and remove the smear layer. Single-cone obturation has been performed by utilizing matched gutta-percha cones and AH Plus "resin-based sealer. AH Plus was selected" due to its low solubility and excellent sealing ability. Schäfer and Zandbiglari found AH Plus to be least soluble among tested sealers, even in artificial saliva.[4,17,25]

While single-cone techniques offer procedural simplicity, they demand precise canal shaping and excellent sealer adaptation. According to Anisha Kumar and A.R. Vivekananda Pai, the greater taper of well-fitted cones can generate hydraulic forces that push sealer apically and compress voids. However, excess sealer may backflow coronally, potentially causing voids in middle and coronal thirds.[22]

Assessment Criteria and Imaging Modality:

The obturation quality was assessed using CBCT imaging, which offers non-destructive, three-dimensional visualization and superior void detection compared to conventional radiographs. CBCT was favored over dye leakage and cross-sectional methods, which can be destructive and less clinically reliable.[21,22]

CBCT imaging, though susceptible to artifacts due to intracanal materials, remains a gold standard for evaluating obturation homogeneity. Research by "Gupta et al., Singh R et al., Huybrechts et al. validate" CBCT's utility in void detection, root morphology assessment, and treatment planning.[2,17,19]

Total of 48 mandibular premolars have been divided into three groups (n is equal to 16 each). Obturation was evaluated using Coll or Sadrian criteria:

Underfilled (Score 1): Filling greater than 2 millimeters short of apex

Optimal (Score 2): Filling up to 2 millimeters short of apex

Overfilled (Score 3): Filling beyond apex

CBCT evaluation focused on obturation length and density. Chi-square statistical analysis revealed the following:

Length of Obturation:

ProTaper Next: 87.5% acceptable

GenENDO: 56.25% acceptable

Neo Endo S: 37.5% acceptable

Chi-square value: 8.537 | p = 0.01401

Density of Obturation:

ProTaper Next: 93.75% acceptable

GenENDO: 62.5% acceptable

Neo Endo S: 50% acceptable

Chi-square value: 7.564 | p = 0.02278

These results confirm that ProTaper Next produced the most favorable obturation outcomes in terms of length and density, with statistically significant differences among groups.

Void Formation and Contributing Factors:

Voids were present in all groups, highlighting the challenge of achieving a completely sealed canal. According to Akman et al., voids may result from improper sealer manipulation, air entrapment during mixing, or poor flow properties.[22,24]

The canal's anatomical complexity, preparation quality, and operator skill also influence obturation quality. Even under ideal conditions, complete void elimination remains difficult, emphasizing the need for optimal instrumentation and sealer characteristics.

Study Limitations and Recommendations:

- Despite methodological rigor, this in vitro study had certain limitations:
- In-vitro design: Clinical replication is limited due to absence of physiological conditions
- Sample homogeneity: Only straight-rooted mandibular premolars were used

6. CONCLUSION

The present in vitro study clearly demonstrates significant differences in performance of three evaluated endodontic file systems. Among them, ProTaper NEXT emerged as the most effective system, exhibiting highest percentage of both

acceptable obturation (87.5 percent), acceptable obturation density (93.75%). This indicates its superior ability to shape root canal and ensure dense, void-free filling.

In comparison, the Coltene GEN Z system showed moderate performance, with 62.5% acceptable results in both parameters. The Neo Endo S system recorded the lowest performance, with only 37.5% acceptable obturation and 50% acceptable density, suggesting limitations in its shaping and filling efficiency.

These findings suggest that file system design, metallurgy, and taper significantly influence the quality of root canal obturation. ProTaper NEXT, with its advanced design features, may offer better clinical outcomes in endodontic therapy.

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