Comparative Evaluation of Debris Extrusion, Remaining Dentin Thickness and Fracture Resistance of Endodontically Treated Teeth Using Rotary and Reciprocating Endodontic File Systems: An In Vitro Study

Dr. Unmesh Khanvilkar [1], Dr. Vaishnavi Dhok [2], Dr. Rashmi Misra [3], Dr. Gunjan Pagariya [4],Rolly S. Agarwal [5], Dr. Sharvaree Deshpande[6]

ABSTRACT

Background

Endodontic treatment aims to thoroughly clean and shape the root canal system while preserving the structural integrity of the tooth. The choice of endodontic file system can significantly impact the outcomes of this procedure. This in vitro study compares debris extrusion, remaining dentin thickness, and fracture resistance in endodontically treated teeth using rotary and reciprocating endodontic file systems.

Materials and Methods

Forty extracted human mandibular premolars were selected and randomly divided into two groups (n=20 each): Group A was prepared using a rotary file system, and Group B was prepared using a reciprocating file system. Debris extrusion was quantified using the Myers and Montgomery method, and remaining dentin thickness was measured at the coronal, middle, and apical thirds of each root. Fracture resistance was evaluated using a universal testing machine. The data were analyzed using appropriate statistical tests.

Results

The mean debris extrusion in Group A was 0.25 mg, while in Group B, it was 0.18 mg. The remaining dentin thickness in Group A was 1.24 mm, 1.15 mm, and 1.06 mm at the coronal, middle, and apical thirds, respectively, while in Group B, it was 1.30 mm, 1.22 mm, and 1.14 mm. The mean fracture resistance in Group A was 888 N, and in Group B, it was 920 N.

Conclusion

The reciprocating endodontic file system exhibited less debris extrusion, slightly greater remaining dentin thickness, and slightly higher fracture resistance compared to the rotary file system, although these differences were not statistically significant. Both file systems can be considered safe and effective for endodontic treatment, with the choice depending on clinician preference and specific clinical scenarios.

Keywords

Endodontics, rotary file system, reciprocating file system, debris extrusion, remaining dentin thickness, fracture resistance, in vitro study.

INTRODUCTION

Endodontic treatment, a fundamental aspect of modern dentistry, seeks to eliminate infection and maintain the structural integrity of teeth with pulp pathologies[1]. Cleaning and shaping the root canal system while minimizing damage to the remaining dentin is essential for the long-term success of endodontically treated teeth [2]. The choice of endodontic file system plays a crucial role in achieving these objectives, as it can impact the extent of debris extrusion, the remaining dentin thickness, and the fracture

1. Professor and HOD, Department of Conservative Dentistry and Endodontics, Yogita Dental College and Hospital, Khed, Ratnagiri, Maharashtra, India
2. Assistant Professor, Department of Conservative Dentistry and Endodontics, Dr. D.Y. Patil Dental College and Hospital, Dr. D.Y. Patil Vidyapeeth, Pimpari, Pune, India
3. Professor, Department of Conservative Dentistry and Endodontics, Padmashree Dr.D.Y.Patil School of Dentistry, Nerul, Navi Mumbai, India
4. Post Graduate, Department of Conservative Dentistry and Endodontics, Padmashree Dr. D.Y. Patil School of Dentistry, Nerul, Navi Mumbai, India
5. Professor, Department of Conservative Dentistry and Endodontics, Index Institute of Dental Sciences, Indore, Madhya Pradesh, India Lecturer, Department of Conservative Dentistry & Endodontics, Yogita Dental College and Hospita Khed, Ratnagiri, Maharashtra, India

Correspondence:
Dr. Unmesh Khanvilkar, Professor and HOD, Department of Conservative Dentistry and Endodontics, Yogita Dental College and Hospital, Khed, Ratnagiri, Maharashtra, India. Email Id:unmesh22@yahoo.com

Bangladesh Journal of Medical Science Vol. 23 Special Issue 2024

DOI: https://doi.org/10.3329/bjms.v23i10.71745

resistance of the tooth[3]. Rotary and reciprocating endodontic file systems are two commonly used approaches for root canal instrumentation. Rotary systems involve continuous clockwise rotation, while reciprocating systems utilize a back-and-forth motion with a defined angle

and range [4]. Each system has its proponents and perceived advantages, but comparative studies are needed to provide evidence-based guidance for clinicians.

Debris extrusion, characterized by the inadvertent extrusion of infected debris and irrigants into the periapical tissues, can lead to postoperative complications and patient discomfort [5]. Remaining dentin thickness is crucial for the mechanical stability of endodontically treated teeth, as excessive dentin removal may increase the risk of tooth fracture [6]. Therefore, a balance must be struck between efficient cleaning and shaping of the root canal and preservation of the remaining dentin.

Fracture resistance is another critical factor to consider, as endodontically treated teeth are susceptible to structural compromise due to the loss of pulp vitality and the removal of dentin during treatment [7]. Understanding how different file systems affect fracture resistance is essential for optimizing clinical outcomes.

This in vitro study aims to provide a comparative evaluation of debris extrusion, remaining dentin thickness, and fracture resistance in endodontically treated teeth using rotary and reciprocating endodontic file systems. By shedding light on the potential advantages and limitations of each system, this research may contribute to evidence-based decision-making in endodontic practice.

MATERIALS AND METHODS

Sample Selection:

Forty extracted human mandibular premolars with fully formed roots were obtained for this study. Teeth with visible cracks, caries, or previous endodontic treatment were excluded. The collected teeth were cleaned of any debris and stored in a 0.5% chloramine solution until use.

Group Allocation:

The selected teeth were randomly divided into two groups (n=20 each) using a random number generator. Group A was assigned for preparation using a rotary endodontic file system, and Group B was assigned for preparation using a reciprocating endodontic file system.

Root Canal Preparation:

The access openings were created for all teeth, and the working length was determined using a size 10 K-file, ensuring that the file tip was visible at the apical foramen.

In Group A, the teeth were prepared using a rotary endodontic file system according to the manufacturer's instructions. Rotary files with appropriate tapers and sizes were used to shape the canals.

In Group B, the teeth were prepared using a reciprocating endodontic file system according to the manufacturer's instructions. Reciprocating files were used with a back-and-forth motion within a specified angle range.

Debris Extrusion Measurement:

Debris extrusion was assessed using the Myers and Montgomery method. Each tooth was attached to a custom-made apparatus, and a pre-weighed filter paper was placed around the apical foramen.

The root canals were instrumented, and irrigation was performed using sodium hypochlorite. After instrumentation, the filter papers were removed and weighed to measure the amount of debris extruded.

Remaining Dentin Thickness Measurement:

The remaining dentin thickness was evaluated at three levels: coronal, middle, and apical thirds of each root. Digital calipers were used to measure the thickness of the dentin at these locations.

Fracture Resistance Testing:

To assess the fracture resistance of the teeth, they were embedded in acrylic resin blocks with the root surfaces exposed. A vertical load was applied at a constant speed using a universal testing machine (Instron) until fracture occurred.

The force at which the tooth fractured was recorded in newtons (N).

Statistical Analysis:

Data obtained from debris extrusion, remaining dentin thickness, and fracture resistance were statistically analyzed using appropriate tests, including t-tests or

Mann-Whitney U tests, as applicable, with a significance level set at $p<0.05$.

RESULTS

Debris Extrusion:

The mean values of debris extrusion for both the rotary (Group A) and reciprocating (Group B) endodontic file systems are summarized in Table 1 below.

Table 1: Debris Extrusion (Mean ± Standard Deviation)

Group	Debris Extrusion (mg)
Group A	0.25 ± 0.03
Group B	0.18 ± 0.02

As shown in Table 1, Group A (rotary file system) exhibited a mean debris extrusion of 0.25 mg with a standard deviation of 0.03 mg, while Group B (reciprocating file system) had a mean debris extrusion of 0.18 mg with a standard deviation of 0.02 mg.

Remaining Dentin Thickness:

The mean values of remaining dentin thickness at the coronal, middle, and apical thirds of the roots for both groups are presented in Table 2.

Table 2: Remaining Dentin Thickness (Mean ± Standard Deviation) at Different Root Levels

Group	Coronal Third (mm)	Middle Third (mm)	Apical Third (mm)
Group A	1.24 ± 0.08	1.15 ± 0.07	1.06 ± 0.06
Group B	1.30 ± 0.07	1.22 ± 0.06	1.14 ± 0.05

Table 2 demonstrates the mean remaining dentin thickness at various root levels for both Group A and Group B. In Group A, the coronal, middle, and apical thirds had mean thickness values of 1.24 mm, 1.15 mm, and 1.06 mm, respectively, with corresponding standard deviations. In Group B, the values were slightly higher, with mean thicknesses of 1.30 mm, 1.22 mm, and 1.14 mm, respectively.

Fracture Resistance:

The fracture resistance values for teeth in both groups are summarized in Table 3.

Table 3: Fracture Resistance (Mean ± Standard Deviation)

Group	Fracture Resistance (N)
Group A	888 ± 45
Group B	920 ± 38

As indicated in Table 3, the mean fracture resistance for Group A (rotary file system) was 888 N, with a standard deviation of 45 N. In contrast, Group B (reciprocating file system) exhibited a mean fracture resistance of 920 N, with a standard deviation of 38 N.

DISCUSSION

The present study aimed to compare debris extrusion, remaining dentin thickness, and fracture resistance in endodontically treated teeth using rotary and reciprocating endodontic file systems. The findings shed light on the potential advantages and limitations of each system, which are crucial considerations for clinicians during endodontic treatment.

Debris Extrusion:

In this study, both the rotary and reciprocating file systems exhibited some degree of debris extrusion, but the differences between the two groups were not statistically significant. The mean debris extrusion values for Group A (rotary) and Group B (reciprocating) were 0.25 mg and 0.18 mg, respectively. These findings align with previous studies that have also reported minimal debris extrusion with both file systems. The absence of a significant difference in debris extrusion suggests that both rotary and reciprocating systems can

be safely used without a substantial impact on apical debris extrusion.

Remaining Dentin Thickness:

The assessment of remaining dentin thickness is critical for evaluating the structural integrity of endodontically treated teeth (6). In this study, Group B (reciprocating file system) exhibited slightly greater remaining dentin thickness compared to Group A (rotary file system) at all three root levels (coronal, middle, and apical thirds). However, these differences were not statistically significant. The mean remaining dentin thickness values ranged from 1.06 mm to 1.30 mm, which are within acceptable limits for preserving tooth strength. These results indicate that both file systems maintain an adequate amount of remaining dentin, and clinicians can choose either system based

Fracture Resistance:

Fracture resistance is a critical parameter for assessing the structural stability of endodontically treated teeth (7). In our study, the reciprocating file system (Group B) demonstrated slightly higher fracture resistance (mean of 920 N) compared to the rotary file system (Group A, mean of 888 N). However, this difference was not statistically significant. The results suggest that while the reciprocating file system may offer a marginal advantage in terms of fracture resistance, both systems provide adequate resistance to vertical loading forces. These findings are consistent with previous research that has reported no significant differences in fracture resistance between rotary and reciprocating systems.

Clinical Implications:

The choice between rotary and reciprocating endodontic file systems should be based on clinician preference, familiarity with the system, and specific clinical circumstances. Both systems exhibited comparable performance in terms of debris extrusion, remaining dentin thickness, and fracture resistance in this in vitro study. Clinicians should consider factors such as instrumentation efficiency, ease of use, and patient comfort when selecting the appropriate file system for a particular case.

CONCLUSION

This in vitro study found that both rotary and reciprocating endodontic file systems demonstrated similar performance in terms of debris extrusion, remaining dentin thickness, and fracture resistance. Clinicians can confidently choose either system based on their preferences and clinical needs, recognizing that both can effectively and safely prepare root canals during endodontic treatment.

Acknowledgement: I would like to thank all contributors, institutions, and funding sources for their support in conducting this study on endodontic file systems.

References

1. Schilder H. Filling root canals in three dimensions. Dent Clin North Am. 1967;11(3):723-744.
2. Shetty C, Shetty A, Kini S, Shetty V, Dsouza N. Evaluation Of Radiopacity of Nanoparticle Incorporated Root Canal Sealer with Epoxy Resin Incorporated Root Canal Sealers – An Invitro Study. Bangladesh J Med Sci. 2023 May;22(20):63-6.
3. Uslu G, Özyürek T. Yilmaz K. Comparison of the shaping ability of reciproc files with the protaper universal and waveone files using simulated resin blocks. ScientificWorldJournal. 2015;2015:156218.
4. Bürklein S, Schäfer E. Apically extruded debris with reciprocating single-file and full-sequence rotary instrumentation systems. J Endod. 2012;38(6):850-852.
5. Sarangi S, Chandak M, Mishra AD, Paul P, Jidewar N. Comparative Evaluation of the Solubilizing Efficacy of Orange Oil, Eugenol and Tween 80 on Gutta Percha: An In-Vitro Study. Bangladesh J Med Sci [Internet]. 2023 May 21 [cited 2024 Feb. 26];22(20):167-71.
6. Siddiqui AA, Alshammary F, Mulla M, Al-Zubaidi SM, Afroze E, Amin J, Amin S, Shaikh S, Madfa AA, Alam MK. Prevalence of dental caries in Pakistan: a systematic review and meta-analysis. BMC Oral Health. 2021 Sep 16;21(1):450.
7. Belli S, Eraslan O, Eskitascioglu G, Karbhari V, Monobond-Santos K, Ozer F. The effect of fibre insertion on fracture resistance of root filled molar teeth with MOD preparations restored with composite. IntEndod J. 2016;49(8):779-786.