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IP Indian Journal of Conservative and Endodontics

Journal homepage: https://ijce.in/

Original Research Article

Comparative evaluation of postoperative pain using continuous and reciprocating motion rotary file systems – A clinical trial

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Abstract

Introduction: Post-operative pain is a common complication following root canal therapy, often caused by extrusion of debris, microorganisms, or irrigants into periapical tissues. The design and kinematics of endodontic file systems—rotary or reciprocating—may influence the degree of post-treatment discomfort, making their clinical comparison highly relevant.

Aim & Objective: The aim of this study was to comparatively evaluate post-operative pain using ProTaper Next and TruNatomy rotary files in continuous motion and One RECI and Neo-endo reciprocation files in reciprocating motion.

Materials and Methods: A total of 100 patients indicated for root canal therapy were randomly allocated into five groups: Control Group: Hand ProTaper, Group 1: ProTaper Next (continuous motion), Group 2: TruNatomy (continuous motion), Group 3: One RECI (reciprocating motion), Group 4: Neo-Endo (reciprocating motion). All procedures were performed using standardized protocols. Pain intensity was measured using the Numerical Rating Scale (NRS) at 8, 24, 48, and 72 hours post-operatively. The data were analyzed statistically using SPSS software.

Results: At 8 and 24 hours, the ProTaper Next group reported the highest pain levels (3.65 ± 3.64 and 4.05 ± 3.49), while the One RECI group showed the lowest scores (0.60 ± 0.82 and 0.10 ± 0.31). Pain levels decreased across all groups at 48 hours, with One RECI reporting no pain (0.00 ± 0.00). By 72 hours, One RECI and Neo-Endo groups demonstrated minimal pain, whereas the ProTaper Next group continued to show the highest post-operative discomfort (3.20 ± 3.30).

Conclusion: Reciprocating file systems such as One RECI and Neo-Endo resulted in significantly lower post-operative pain compared to continuous motion systems. These findings suggest a clinical advantage of reciprocating motion in improving patient comfort after endodontic treatment.

Keywords: Post-operative pain, Root canal therapy, Rotary instrumentation, Reciprocating files, Continuous motion, Endodontics.

Received: 11-07-2025; **Accepted:** 13-08-2025; **Available Online**: 08-10-2025

1. Introduction

Pain following endodontic therapy is known as post-endodontic pain, and its severity has been described in a range of 25% to 40%, affecting 1.5% to over 50% of patients, irrespective of pulp and periradicular health.[1-3]

Numerous factors can contribute to post endodontic discomfort. During chemomechanical preparation, dentinal debris, pulp tissue, microbes, and irrigants may be extruded into the periapical tissues, causing inflammation.[4,5]

Gender, type of the tooth, improper instrumentation, extrusion of irrigant, missed canals, pre-operative pain, periapical pathosis, apical debris extrusion, intracanal dressing extrusion between appointments, any occlusal prematurity, and apical patency during the preparation of root canal are some of the factors that can cause post-obturation pain. The kind of cleaning and shaping technique that could lead to the ejection of debris into the periapical region is another element that could be another contributing factor to post-obturation pain.[5-7]

When material is extruded from the periapical region, it can cause inflammation, which raises prostaglandin levels and typically causes pain.[8] Hence, the infectious debris extrusion into the periapical tissues during the cleaning and

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https://doi.org/10.18231/j.ijce.12278.1758516420

shaping of a root canal is purportedly one of the major causes of post-operative pain.[9]

When compared to reciprocation systems, rotary systems have been shown in numerous randomized clinical trials to have a lower incidence of postoperative discomfort.[10-12]

Endodontic instruments are always being modified to improve clinical safety during use and to perform better while cleaning and shaping a root canal to maximize treatment success.[13]

Quick technical developments in the instrumentation systems of endodontics bring new design ideas that promise simpler, quicker preparations while maintaining the original canal anatomy with significantly lower iatrogenic error.[14,15]

The manufacturers also claim to achieve more favorable treatment outcomes with a lower rate of postoperative pain.[16] Current mechanical preparation of root canals uses rotary nickel-titanium (NiTi) instruments that employ either of the two kinematics (rotation or reciprocation).[17]

Several methods have been devised to alleviate discomfort, such as providing preventive analgesics and corticosteroids, preparing root canals using the crown-down approach, administering long-lasting anesthetics, and occlusal reduction.[18] Despite being relatively safe medications, NSAIDS have been linked to respiratory, hepatic, and renal problems, including asthma, as well as gastrointestinal intolerance.[19]

A recently launched file system called TruNatomy (TN; Dentsply Sirona, Maillefer, Ballaigues, Switzerland) is made using 0.8 mm NiTi wire rather than 1.2 mm NiTi wire, which is utilized to make the majority of generic files, after which they undergo a unique heat treatment. TruNatomy is said to have a lower chance of separation because of its greater flexibility and tolerance to cycle fatigue.

A single-use reciprocating tool for root canal shaping is the One RECI (OR; Micromega, Besançon, France). MicroMega One RECI is made of nickel titanium, has been heat-treated using C.Wire, and features a proprietary variable cutting section design that provides a great balance between cutting efficiency and flexibility. The reciprocating motion of the MicroMega One RECI provides comfort, safety, and resistance to cycle fatigue.

The Neo-Endo Reciprocation file (Orikam Healthcare India Private Limited) is meant to be used in a 150-degree counter lock wise direction and a 30-degree clockwise direction. The angle of the cutting direction is greater than the angle of the stress release direction. This reduces the risk of instrument fracture.

The ProTaper Next® system is the replacement for the ProTaper® Universal system, which for many years has been the industry standard in endodontics. More severely bent small canals can be shaped using the ProTaper Next® files' distinctive swaggering action and increased flexibility than was previously possible with the majority of NiTi systems available on the market.

ProTaper Next®'s unique off-center rectangular cross shape allows the file to "swagger" into the root canal like a snake. The file's distinctive form and off-center cross-section create more room for efficient debris extrusion. Clinicians can choose the best strategy to improve patient comfort and treatment outcomes by determining the most effective file system.

An issue that frequently arises after root canal therapy and compromises patient comfort and satisfaction is post-operative pain. Different endodontic file systems make claims about reducing pain, but there isn't enough evidence to determine which method works best. The purpose of this study is to assess the prevalence of post-endodontic discomfort between the TruNatomy, One RECI, Neo-Endo Reciprocation, and ProTaper Next rotary and reciprocating file systems to identify which one offers the best post-treatment experience. Clinicians can choose the best instrumentation strategy for optimal patient care by knowing how debris extrusion, file kinematics, and post-operative pain are related.

2. Materials and Methods

This study was conducted in the Department of Conservative Dentistry and Endodontics at ITS Dental College and Research Centre, Greater Noida. Ethical approval was obtained from the institutional ethics committee, and informed consent was secured from all participants before enrollment. This trial was registered in the Clinical Trials Registry of India.

2.1. Sample size calculation

Level of significance = 5%, Power = 80%, Type of test = two-sided

Formula of calculating sample size is: Sample size for experimental study (outcome variable on ratio scale and testing null hypothesis

$$n = 2\frac{s^2\left(Z1+Z2\right)^2}{\left(M1-M2\right)^2}$$

F tests - ANOVA: Fixed effects, omnibus, one-way

Analysis: A priori: Compute required sample size

Input	Effect size f	0.4
	α err prob	0.05
	Power (1-β err prob)	0.8
	Number of sub-groups	4
Output	Noncentrality parameter λ	12.16
	Critical F	2.7318
	Numerator df	3

	Denominator df	72
	Total sample size	76
	Actual power	0.8234

A power analysis was established by G*Power version 3.0.1(Franz Faul Universität, Kiel, Germany). Total minimum calculated sample size of 96 rounded to 100 samples (20 samples per group; total 5 sub-groups) would yield 80% power to detect significant differences, with effect size of 0.4 and significance level at 0.05.

2.2. Inclusion criteria

Vital teeth indicated for intentional RCT, Age group- 20-50 years, Single or multi rooted teeth (radiographically and clinically assessed), Patients with completely formed roots(mature apex), Teeth with only Vertucci Type 1 root canal morphology, Patients consenting to be a part of this study, Medically fit patients (i.e no general disease or pregnancy).

2.3. Exclusion criteria

Teeth with wide or open apex, Non vital teeth, Endodontic retreatment cases, Third molars, Patients using analgesics, NSAIDs or anxiolytics within 7 days before the procedure, Teeth with poor prognosis, Teeth with complex root canal morphology, Patients unwilling to participate in the study, Patients with active pain in any tooth, Pregnant patients and nursing mothers, Presence of systemic diseases such as cardiovascular disease, renal disease and any bleeding disorders.

A pilot study was conducted prior to the main research to assess the feasibility, methodology, and potential challenges of the study titled "Comparative Evaluation of Post-Operative Pain Using Continuous and Reciprocating Motion Rotary File Systems - A Clinical Trial." Five participants from each group were selected based on the inclusion criteria, and the same clinical procedures were followed as planned for the main study. The feasibility of patient recruitment, the reliability of pain assessment using the Numerical Rating Scale (NRS), and the effectiveness of randomization were examined. Any procedural difficulties, inconsistencies in data collection, or unforeseen challenges were identified and addressed accordingly.

A total of 100 patients who met the inclusion criteria were randomly divided into five equal groups of 20 participants each:

1. Group 1: Hand Protaper files (Control group)
2. Group 2: ProTaper Next rotary files
3. Group 3: TruNatomy rotary files
4. Group 4: One RECI reciprocating files
5. Group 5: Neo Endo reciprocating files

All procedures were carried out by a single trained operator to maintain consistency. Local anesthesia was administered using 2% lidocaine with 1:80,000 epinephrine. Occlusal reduction was performed prior to canal instrumentation as a preventive measure to reduce post-operative discomfort. Access was gained using a sterile #2 round bur, followed by working length determination via intraoral periapical radiographs and confirmation with an electronic apex locator.

A glide path was established, and canal orifices were enlarged before biomechanical preparation using the designated file system for each group—either in continuous rotary or reciprocating motion.

Root canal irrigation was performed using a 30-gauge side-vented needle. A total of 5 ml of 3% sodium hypochlorite was used during instrumentation, alternating with normal saline. This was followed by irrigation with 5 ml of 17% EDTA, and final flushing was performed with 10 ml of saline. All cases followed a two-visit protocol. No intracanal medicament was placed between appointments, ensuring that any potential contribution of intracanal medicaments to inter-appointment pain or flare-ups was eliminated from affecting the outcomes. Access cavities were sealed temporarily with restorative material after cleaning and shaping.

Post-operative pain was assessed using the Numeric Rating Scale (NRS), a standard tool for measuring pain intensity. Patients were asked to report their pain levels at baseline 8 hours, 24 hours, 48 hours, and 72 hours after treatment. Pain scores were collected telephonically by an independent, blinded evaluator to reduce bias.

Data were organized using Microsoft Excel, and statistical analysis was performed using SPSS version 24. Mean and standard deviation were calculated for continuous variables, while categorical variables were represented using frequencies and percentages. One-way ANOVA followed by Tukey's post hoc test was used for intergroup comparisons. Repeated measures ANOVA was employed for intragroup comparisons across time points. A p-value less than 0.05 was considered statistically significant.

3. Results

Pain intensity was evaluated at multiple intervals—8, 24, 48, and 72 hours post-treatment—across all five groups using the Numeric Rating Scale (NRS). The intergroup differences were statistically significant at all-time points, with $p < 0.001$, indicating that the type of instrumentation had a notable impact on post-operative pain levels.

At 8 hours post-intervention, the highest mean pain score was recorded in the ProTaper Next group (3.65 ± 3.64), followed by the Control group using Hand Protapers (2.70 ± 1.95). The TruNatomy group reported a slightly lower score (2.00 ± 2.05). In contrast, both reciprocating file systems—NeoEndo (1.05 ± 1.19) and One RECI (0.60 ± 0.82)—exhibited significantly reduced pain levels.

Table 1: Comparison of pain of different groups from 8 to 72 hours.

Group	8 hours		24 hours		48 hours		72 hours		P-value (intragroup comparison)
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Control	2.70	1.95	2.45	2.50	1.75	2.17	1.20	1.99	<0.001*
Trunatomy	2.00	2.05	1.35	2.16	0.80	1.58	0.45	1.10	0.006*
Protaper next	3.65	3.64	4.05	3.49	3.40	3.32	3.20	3.30	<0.001*
NEO ENDO	1.05	1.19	0.75	1.25	0.90	1.17	0.55	0.83	0.001*
ONE RECI	0.60	0.82	0.10	0.31	0.00	0.00	0.00	0.00	0.009*
P value (intergroup comparison)	<0.001*		<0.001*		<0.001*		<0.001*		

At 24 hours, the ProTaper Next group continued to show the highest mean pain score (4.05 ± 3.49), whereas the Control (2.45 ± 2.50) and TruNatomy (1.35 ± 2.16) groups demonstrated a gradual decline. Notably, the NeoEndo (0.75 ± 1.25) and One RECI (0.10 ± 0.31) groups maintained low pain scores, further supporting the favorable performance of reciprocating systems.

At 48 hours, pain levels declined across most groups. The ProTaper Next group still reported a relatively high score (3.40 ± 3.32), whereas Control (1.75 ± 2.17) and TruNatomy (0.80 ± 1.58) groups showed continued improvement. The NeoEndo group registered a mean score of 0.90 ± 1.17, while the One RECI group reported no pain (0.00 ± 0.00) in all participants.

At 72 hours, the ProTaper Next group retained the highest residual pain (3.20 ± 3.30), although slightly decreased. Pain further reduced in the Control (1.20 ± 1.99) and TruNatomy (0.45 ± 1.10) groups. The NeoEndo group recorded a score of 0.55 ± 0.83, and One RECI again showed complete absence of pain (0.00 ± 0.00).

3.1. Intragroup analysis

1. Control group: Pain decreased steadily from 2.70 ± 1.95 at 8 hours to 1.20 ± 1.99 at 72 hours ($p < 0.001$).
2. TruNatomy group: A significant reduction in pain was observed, from 2.00 ± 2.05 at 8 hours to 0.45 ± 1.10 at 72 hours ($p = 0.006$).
3. ProTaper Next group: Although pain scores fluctuated slightly, the overall trend showed a decrease from 3.65 ± 3.64 to 3.20 ± 3.30 by 72 hours ($p < 0.001$).
4. NeoEndo group: Demonstrated a marked decline in pain from 1.05 ± 1.19 to 0.55 ± 0.83 ($p = 0.001$).
5. One RECI group: Showed the most pronounced reduction, with scores falling from 0.60 ± 0.82 to 0.00 ± 0.00 by 48 hours and remaining at zero through 72 hours ($p = 0.009$).

These results clearly suggest that reciprocating file systems, particularly One RECI, are associated with significantly reduced post-operative pain when compared to both rotary and hand instrumentation systems. (**Table 1**)

4. Discussion

This clinical investigation explored the effect of different file kinematics on postoperative endodontic pain, emphasizing its multifactorial nature. While earlier research has suggested that reciprocating motion may be advantageous, the present study was essential to validate and contextualize these findings under controlled clinical conditions. Even with ongoing improvements in instrument metallurgy and canal preparation techniques, none of the systems could eliminate postoperative pain entirely, reaffirming the complexity of pain outcomes in endodontic therapy.

Pain after root canal treatment is not solely determined by instrumentation technique. It results from a cascade of inflammatory events triggered by mechanical and microbial irritation of periapical tissues. Common mediators—prostaglandins, bradykinin, histamine, and leukotrienes—contribute to this inflammatory response. The extrusion of debris and bacteria during instrumentation continues to be a primary contributing factor, even in asymptomatic or vital teeth.

To reduce confounding variables, this study focused on asymptomatic, vital teeth undergoing endodontic therapy for prosthodontic reasons. Standardization across multiple parameters—such as the number of visits, irrigants used, obturation technique, and postoperative pain evaluation tool (NRS)—helped isolate the influence of file motion.

Our findings indicated that patients treated with reciprocating systems experienced significantly less postoperative discomfort at 8, 24, 48, and 72 hours, as compared to those treated with rotary systems. This aligns with earlier studies, including Neelakantan and Sharma,[20] who reported that reciprocating kinematics led to more reliable root canal shaping with reduced pain levels. Similarly, Bhojwani et al.[21] found that WaveOne Gold—a reciprocating system—was associated with less pain than TruNatomy, a rotary file system. The reduced apical extrusion often linked with reciprocation may explain this clinical advantage.

Moreover, previous in vitro studies have consistently reported that reciprocating systems extrude less debris than continuous rotary systems. Tinoco et al.[22] demonstrated this

using single-file reciprocation. Eliasz et al.[23] also found that WaveOne extruded less debris compared to ProTaper Next and Twisted Files. Ehsani et al.[24] further confirmed these findings by showing that reciprocating systems outperformed both ProTaper Universal and Mtwo systems in reducing extrusion.

However, contrasting data also exist. Nekoofar et al.[10] found that ProTaper Universal rotary systems resulted in significantly less postoperative pain than WaveOne. Likewise, Kherlakian et al.[25] concluded that both rotary and reciprocating systems were comparable in pain outcomes, indicating that other factors—such as preoperative condition, irrigation protocol, obturation technique, and operator experience—might influence the results.

Notably, One RECI, the reciprocating file system used in this study, consistently produced lower pain scores across all time intervals. This could be attributed to its conservative cutting design, enhanced control over debris extrusion, and minimized stress on periapical tissues. These characteristics may collectively contribute to the improved postoperative experience seen in this cohort.

Hence, while existing literature provides a foundation, our study adds depth by offering clinical evidence under standardized conditions. It reinforces that reciprocating systems—though not universally superior—may offer significant advantages in reducing postoperative discomfort in specific clinical scenarios.

5. Conclusion

Within the limitations of this study, it can be concluded that the type of instrumentation system significantly influences the incidence and intensity of postoperative pain following root canal therapy. Among the systems evaluated, the One RECI reciprocating file system demonstrated the lowest pain levels at all measured intervals, suggesting it may offer superior patient comfort. In contrast, the ProTaper Next rotary system was associated with the highest levels of postoperative discomfort. While the TruNatomy and Neo-Endo systems produced moderate and comparable pain responses, the overall findings support the clinical advantage of reciprocating motion in minimizing postoperative endodontic pain.

6. Author Contribution

1. Dr. Sonal Mukhraiya: Conceptualization, Data curation, Investigation, Methodology, Writing – original draft, Writing – review editing.
2. Dr. Mansi Punjabi: Conceptualization, Formal analysis, Methodology, Project administration, Supervision, Writing – review editing.
3. Dr. Apoorva Sharma: Formal analysis, Methodology, Writing – review editing.
4. Dr. Rohit Kochhar: Conceptualization, Formal analysis, Methodology, Project administration, Supervision, Validation, Visualization, Writing – review editing.
5. Dr. Manju Kumari: Conceptualization, Formal analysis, Methodology, Project administration, Supervision, Writing – review editing.

7. Ethical Approval.

IEC/Cons/10/23.

8. Source of Funding

None.

9. Conflict of Interest

None.

10. Acknowledgement

None.

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Cite this article: Mukhraiya S, Punjabi M, Sharma A, Kochhar R, Kumari M. Comparative evaluation of postoperative pain using continuous and reciprocating motion rotary file systems – A clinical trial. *IP Indian J Conserv Endod*. 2025;10(3):185-190.