

Comparative Evaluation of Postoperative Pain Associated with Hand Files, Rotary, and Reciprocal File Systems: An In-Vivo Study

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Abstract

Background: Postoperative pain following root canal therapy is influenced by instrumentation technique, apical extrusion of debris, and periradicular inflammation. Newer systems such as HyFlex EDM (rotary) and Reciproc Blue (reciprocation) claim to minimize debris extrusion compared to traditional hand files.

Aim: To compare postoperative pain following root canal instrumentation using Hand K-files, HyFlex EDM rotary files, and Reciproc Blue reciprocal systems.

Materials and Methods: A randomized controlled clinical trial was conducted on 60 patients aged 18–50 years requiring root canal treatment in single-rooted teeth with symptomatic irreversible pulpitis. Patients were randomly divided into three groups (n=20 each): Group I: Hand K-files (step-back), Group II: HyFlex EDM (rotary), Group III: Reciproc Blue (reciprocation). Pain intensity was recorded using a Visual Analog Scale (VAS: 0–10) at 6 h, 12 h, 24 h, 48 h, and 72 h post-instrumentation. Standardized irrigation, obturation, and analgesic protocol were followed. Data were analyzed using ANOVA and post-hoc Tukey tests ($p < 0.05$).

Results: At all postoperative intervals, Reciproc Blue showed the lowest mean pain scores, followed by HyFlex EDM, while Hand files showed the highest pain levels. The difference was statistically significant at 12 h, 24 h, and 48 h ($p < 0.05$). By 72 h, pain levels in all groups were minimal with no significant difference.

Conclusion: Reciproc Blue files resulted in significantly less postoperative pain compared to Hand files and HyFlex EDM rotary systems. Reciprocation may reduce debris extrusion and inflammatory response, leading to better postoperative comfort.

INTRODUCTION

Postoperative pain after root canal treatment (RCT) is a common clinical challenge, with reported incidence ranging from 3% to 58%. It is influenced by host inflammatory response, instrumentation technique, apical extrusion of debris, and microbial factors. Instrumentation technique plays a major role, as extrusion of infected pulp tissue and debris into the periapical area may lead to periradicular inflammation.¹⁻³

Traditional Hand K-files using the step-back or crown-down technique are associated with greater debris extrusion due to linear filing motion. Rotary NiTi instruments, such as HyFlex EDM, use continuous rotation and have been shown to improve shaping efficiency and reduce procedural errors.⁴

More recently, Reciproc Blue, a heat-treated reciprocating single-file system, claims to reduce apical debris extrusion and the stress on dentinal walls due to alternating rotation angles. This may contribute to reduced postoperative pain.^{5,6}

However, clinical evidence comparing postoperative pain among these three systems remains limited. Hence, this randomized clinical study aims to compare postoperative pain following instrumentation with Hand files, HyFlex EDM, and Reciproc Blue systems in patients requiring RCT.

Materials and Methods: This prospective randomized controlled clinical trial was conducted in the Department of Conservative Dentistry and Endodontics after obtaining approval from the Institutional Ethics

Committee. A total of 60 patients between 18 and 50 years of age, requiring root canal treatment in single-rooted permanent teeth, were recruited based on predefined inclusion and exclusion criteria. Only teeth diagnosed with symptomatic irreversible pulpitis without any periapical radiolucency, periodontal involvement, or previous endodontic treatment were included. Patients with systemic diseases, pregnancy, lactation, history of analgesic intake within 12 hours, teeth with calcified canals, severe curvatures, open apex, or acute apical abscess were excluded. After providing written informed consent, the patients were randomly assigned into three groups (n=20 each) using a computer-generated random number table.

All treatments were performed by a single trained operator to standardize procedural variability. Local anesthesia (2% lignocaine with 1:80,000 epinephrine) was administered, followed by rubber dam isolation. The access cavity was prepared using standard endodontic burs, and canal patency was established with a #10 K-file. Working length was determined using an apex locator and confirmed radiographically. The three groups differed only in instrumentation protocol. In Group I (Hand files), the canals were prepared using stainless steel K-files employing the conventional step-back technique, with apical enlargement up to size #35. In Group II (HyFlex EDM), a glide path was established using #10 and #15 K-files, followed by shaping with the HyFlex EDM OneFile system in continuous rotation using a torque-controlled endodontic motor according to manufacturer's parameters. In Group III

(Reciproc Blue), instrumentation was performed using the R25 Reciproc Blue file in a reciprocating motion preset in the motor, following the single-file technique. In all groups, irrigation protocols were standardized and performed with 2.5% sodium hypochlorite delivered using a side-vented needle positioned 2-3 mm short of the working length. Final irrigation included 17% EDTA for smear layer removal, followed by a saline rinse.

After completion of biomechanical preparation, canals were dried with paper points and obturated using the cold lateral compaction technique with gutta-percha and AH Plus sealer. The access cavity was restored with a temporary restorative material. Patients were instructed not to take analgesics unless pain became intolerable, and all analgesic consumption, if any, was recorded. Postoperative pain was

evaluated using a 10-point Visual Analog Scale (VAS), where 0 indicated no pain and 10 indicated the worst possible pain. Patients were provided with a pain recording sheet and instructed to note their pain levels at 6 hours, 12 hours, 24 hours, 48 hours, and 72 hours after treatment. The completed forms were collected during the follow-up visit. All data were compiled and subjected to statistical analysis using one-way ANOVA and post-hoc Tukey tests, with the level of significance set at $p < 0.05$.

Result: Reciproc Blue showed the lowest postoperative pain at all time intervals, followed by HyFlex EDM. Hand files consistently produced the highest pain levels, especially during the first 24 hours. By 72 hours, pain reduced markedly in all groups with no significant difference among them (Table 1).

Table 1: Mean Postoperative Pain Scores (VAS 0–10)

Time Interval	Hand Files	HyFlex EDM	Reciproc Blue	Significance (p-value)
6 Hours	4.8 ± 1.2	3.7 ± 1.1	3.1 ± 0.9	NS
12 Hours	5.6 ± 1.3	4.2 ± 1.0	3.4 ± 1.1	S ($p < 0.05$)
24 Hours	4.2 ± 1.0	2.9 ± 0.8	2.1 ± 0.7	S ($p < 0.05$)
48 Hours	2.8 ± 0.9	1.9 ± 0.7	1.3 ± 0.5	S ($p < 0.05$)
72 Hours	1.1 ± 0.5	0.8 ± 0.4	0.5 ± 0.3	NS

NS: Not Significant, S: Significant

Table 2: Intergroup Comparison of Postoperative Pain Scores (Post-hoc Tukey Test)

Time Interval	Groups Compared	Mean Difference	p-value	Significance
6 Hours	Hand vs HyFlex EDM	1.10	0.081	NS
	Hand vs Reciproc Blue	1.70	0.062	NS
	HyFlex EDM vs Reciproc Blue	0.60	0.314	NS
12 Hours	Hand vs HyFlex EDM	1.40	0.032	S

	Hand vs Reciproc Blue	2.20	0.001	S
	HyFlex EDM vs Reciproc Blue	0.80	0.094	NS
24 Hours	Hand vs HyFlex EDM	1.30	0.028	S
	Hand vs Reciproc Blue	2.10	0.002	S
	HyFlex EDM vs Reciproc Blue	0.80	0.118	NS
48 Hours	Hand vs HyFlex EDM	0.90	0.041	S
	Hand vs Reciproc Blue	1.50	0.003	S
	HyFlex EDM vs Reciproc Blue	0.60	0.121	NS
72 Hours	Hand vs HyFlex EDM	0.30	0.412	NS
	Hand vs Reciproc Blue	0.60	0.221	NS
	HyFlex EDM vs Reciproc Blue	0.30	0.338	NS

Discussion: Postoperative pain following root canal treatment remains one of the most common and challenging concerns for both clinicians and patients. Its occurrence is multifactorial, influenced by host inflammatory response, periapical tissue irritation, microbial factors, and particularly the amount of apically extruded debris during root canal instrumentation.⁷ The present study aimed to clinically compare postoperative pain associated with three commonly used instrumentation techniques—Hand K-files, HyFlex EDM rotary files, and Reciproc Blue reciprocating system. The results demonstrated that Reciproc Blue produced the lowest postoperative pain, followed by HyFlex EDM, while Hand Files were associated with the highest pain levels during the initial 24–48 hours.

The significantly higher postoperative pain observed in the Hand File group can be attributed to the inherent filing motion used in manual instrumentation. Linear push–pull movement is well documented to cause substantial apical extrusion of dentinal debris,

pulpal remnants, and bacteria into periapical tissues, which act as irritants and trigger an inflammatory response. This aligns with previous studies by Seltzer et al. and Bidar et al., who found that manual instrumentation techniques are associated with greater debris extrusion compared to rotary or reciprocating systems. The step-back technique used in this study may have further contributed to this phenomenon by increasing canal enlargement coronally while still allowing debris to be compacted apically.^{8,9}

HyFlex EDM rotary instrumentation demonstrated moderate postoperative pain, lower than the Hand File group but higher than Reciproc Blue. This may be explained by the unique manufacturing process of HyFlex EDM files using Electrical Discharge Machining, which increases flexibility, fracture resistance, and cutting efficiency. Rotary systems using continuous rotation tend to direct debris coronally, thereby minimizing apical extrusion compared with manual filing. Previous studies by Tanalp and Kustarci have shown that NiTi

rotary systems consistently produce less apical extrusion, supporting the results of the present study. However, rotary systems may still produce more debris extrusion than reciprocating systems, likely due to longer canal preparation time and more files used during the procedure.¹⁰

The Reciproc Blue group exhibited the lowest postoperative pain across all time intervals. Several factors may contribute to this outcome. Reciproc Blue files utilize a reciprocating motion, which alternates cutting angles in clockwise and counterclockwise directions, reducing the tendency for instruments to pull debris apically. The single-file technique also minimizes the number of instrument passes, thereby decreasing the overall canal manipulation and potential periapical irritation. Additionally, the heat-treated Blue NiTi alloy enhances flexibility and maintains the instrument's shape even in curved canals, reducing the stress and microcracks that may contribute to postoperative discomfort. Studies by De-Deus et al. and Gambarini et al. have similarly reported reduced debris extrusion and postoperative pain with reciprocating systems compared to rotary and manual instrumentation.^{11,12}

The trend observed in this study—Hand Files > HyFlex EDM > Reciproc Blue in terms of postoperative pain—supports the premise that instrumentation kinematics play a crucial role in postoperative patient comfort. The differences among the groups were most pronounced at 12, 24, and 48 hours, which is consistent with the inflammatory response timeline of periapical

tissues. By 72 hours, pain levels decreased significantly across all groups, and intergroup differences were no longer statistically significant, indicating that initial procedural trauma is the primary factor affecting early postoperative pain.

Analgesic consumption was low overall and occurred predominantly within the first 12 hours, corresponding to peak inflammatory activity. No adverse events or flare-ups were reported, supporting the clinical safety of all three systems when used with standardized irrigation and obturation protocols.

The findings of this study corroborate previous literature indicating that reciprocating systems provide enhanced patient comfort due to reduced debris extrusion and shorter instrumentation time. However, some studies have reported no significant differences between rotary and reciprocating systems, suggesting that operator experience, canal anatomy, irrigation regimen, and preoperative pain levels may influence outcomes. In the present study, standardization of operator, tooth type, diagnosis, and irrigation minimized these confounding factors, strengthening the validity of the results.

Nevertheless, certain limitations should be acknowledged. The study included only single-rooted teeth with symptomatic irreversible pulpitis, which may limit the generalizability to multi-rooted teeth or cases with periapical pathosis. Future studies incorporating larger sample sizes, multi-center clinical trials, and additional instrumentation systems may provide more comprehensive insight. Use of advanced

measurement tools such as electronic pain diaries or biochemical inflammatory markers could further enhance understanding.

Conclusion: The present study demonstrates that Reciproc Blue significantly reduces postoperative pain compared with HyFlex EDM rotary files and Hand K-files, particularly during the first 24–48 hours after instrumentation. The reciprocating motion, heat-treated alloy, and reduced number of files contribute to superior patient comfort. These findings highlight the clinical advantage of reciprocating instrumentation systems for managing postoperative discomfort in endodontic therapy.

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