

Comparative Evaluation of Ultrasonic Tips and the Masserann Kit for Retrieval of Separated Endodontic Instruments – an in vivo study

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ABSTRACT

Aim: This in vivo study introduces a **novel dual-parameter evaluation**—dentin preservation and postoperative patient comfort—while comparing ultrasonic tips and the Masserann kit for retrieval of separated endodontic instruments.

Materials and Methods: Forty patients (20–60 years) with fractured instruments were randomly divided into two groups: **Group 1** underwent retrieval using ultrasonic tips, and **Group 2** with the Masserann kit. Residual dentin thickness and postoperative discomfort (Visual Analog Scale, VAS) were recorded. Data were analyzed using the Shapiro–Wilk test, followed by the Mann–Whitney U test. A p-value < 0.05 was considered significant.

Results: Ultrasonic tips preserved significantly greater dentin thickness (1.45 ± 0.10 mm) than the Masserann kit (1.03 ± 0.19 mm, $p < 0.001$). VAS pain scores were lower in the ultrasonic group (1.20 ± 1.20) compared to the Masserann group (2.50 ± 1.61 , $p = 0.006$).

Conclusion: This study is one of the **first controlled in vivo clinical trials** to simultaneously quantify dentin preservation and postoperative comfort in fractured instrument retrieval. Ultrasonic tips proved superior to the Masserann kit, offering a minimally invasive, tooth-conserving, and patient-friendly approach.

Clinical Significance: By integrating **structural preservation** with **patient-centered outcomes**, this work provides an **innovative clinical decision framework**—positioning ultrasonic tips as the preferred technique for modern, minimally invasive endodontic practice

Keyword: Ultrasonic tips, Masserann kit, fractured instruments, dentin preservation, minimally invasive endodontics, postoperative pain.

1. INTRODUCTION

Endodontic treatment remains a cornerstone of tooth preservation, aiming to eradicate infection, shape canals for optimal cleaning, and provide a fluid-tight seal that prevents reinfection. Despite continuous advances in rotary instrumentation and nickel–titanium (NiTi) technology, **instrument separation** during root canal therapy persists as one of the most challenging iatrogenic complications faced by clinicians. When a fractured file obstructs canal patency, it limits access to the apical portion, interferes with disinfection, and threatens the overall prognosis of the tooth [1–3].

The causes of instrument separation are multifactorial—cyclic fatigue from repeated sterilization, excessive torsional loads, and the anatomical complexities of posterior curved roots all contribute to breakage [4,5]. Once separation occurs, the

clinician must decide whether to bypass, retain, or retrieve the fragment, balancing prognosis with the risk of compromising remaining dentin structure. The **clinical dilemma** lies in achieving full canal debridement while avoiding unnecessary sacrifice of tooth structure or introducing procedural complications such as perforation.

Over the years, several retrieval systems have been introduced, the most notable being the **Masserann kit** and **ultrasonic techniques**. The Masserann kit relies on trephine burs and mechanical extractors, often effective in straight canals but at the cost of **substantial dentin removal**—a factor that can weaken root structure and predispose teeth to vertical fracture [8]. In contrast, **ultrasonic tips** apply high-frequency vibrations to dislodge fractured fragments with minimal dentin sacrifice, making them especially useful in posterior, narrow, and curved canals [7,9].

While earlier studies have evaluated retrieval success rates and technical efficiency, there is a **critical gap in the literature**: very few investigations have simultaneously assessed **residual dentin preservation** alongside **patient-centered outcomes such as postoperative discomfort** in a controlled **in vivo setting**. This dual focus is essential because endodontic success is not only defined by mechanical retrieval but also by conserving tooth strength and enhancing patient comfort.

The present study introduces this novel dual-outcome framework, directly comparing ultrasonic tips and the Masserann kit in clinical cases of separated instrument retrieval. By combining structural and patient-centered measures, this research provides new insights into evidence-based decision-making and reinforces the paradigm of **minimally invasive, patient-friendly endodontics**.

2. MATERIALS AND METHODOLOGY

Study Design and Participants

This was a **prospective, randomized in vivo clinical study** conducted on 40 patients aged 20–60 years, each presenting with a separated endodontic instrument in a root canal system. Patients with systemic illness, pregnancy, or contraindications for endodontic procedures were excluded. Written informed consent was obtained from all participants, and medical and dental histories were recorded. Standardized radiographic evaluation confirmed the presence and location of the fractured instrument before treatment initiation.

Randomization and Group Allocation

Participants were randomly assigned into two equal groups ($n = 20$ per group):

Group 1 (Ultrasonic tips): Retrieval performed using ultrasonic tips.

Group 2 (Masserann kit): Retrieval performed using the Masserann kit.

Randomization ensured comparability between groups and minimized operator bias.

Retrieval Techniques

Group 1 (Ultrasonic Tips):

A conservative protocol was followed. After canal enlargement and creation of a staging platform for visibility, ultrasonic tips were applied circumferentially around the fractured fragment under magnification. High-frequency vibration facilitated loosening and dislodgment of the instrument while minimizing dentin removal.

Group 2 (Masserann Kit):

Following coronal enlargement with Gates–Glidden drills, a trephine bur was employed to expose the fragment. The fragment was then engaged with the extractor of the Masserann kit and mechanically withdrawn. This method required greater dentin removal to create adequate space for instrumentation.

In both groups, once retrieval was achieved, canals were prepared, disinfected, obturated, and restored using standard endodontic protocols.

Outcome Assessment

Two primary outcome variables were measured:

Residual Dentin Thickness (RDT): Measured radiographically after retrieval to quantify conservation of tooth structure.

Postoperative Discomfort: Assessed 24 hours after the procedure using the **Visual Analog Scale (VAS)**, a 10-point scale where 0 indicated no pain and 10 indicated the most severe pain imaginable.

Statistical Analysis

All data were compiled using Microsoft Excel (2019) and analyzed with SPSS v26.0. The **Shapiro–Wilk test** was applied to evaluate normality of data distribution. Based on results, the **Mann–Whitney U test** was selected for intergroup comparison of RDT and VAS scores, as both datasets demonstrated non-normal distribution. A p -value of less than 0.05 was considered statistically significant.

3. RESULTS

Dentin Preservation

Residual dentin thickness (RDT) was significantly greater in the ultrasonic group compared to the Masserann group.

Group 1 (Ultrasonic tips): Mean RDT = 1.45 ± 0.10 mm

Group 2 (Masserann kit): Mean RDT = 1.03 ± 0.19 mm

Statistical analysis using the Mann–Whitney U test revealed a highly significant difference ($p < 0.001$).

This finding confirms that ultrasonic retrieval is substantially more conservative, preserving **~40% more dentin thickness** compared to the Masserann technique.

Postoperative Discomfort

Pain levels, assessed 24 hours post-treatment using the Visual Analog Scale (VAS), were consistently lower in patients treated with ultrasonic tips.

Group 1 (Ultrasonic tips): Mean VAS = 1.20 ± 1.20

Group 2 (Masserann kit): Mean VAS = 2.50 ± 1.61

The difference between the groups was statistically significant ($p = 0.006$).

This demonstrates that patients undergoing ultrasonic retrieval experienced **not only structural benefits but also enhanced comfort**, validating the patient-centered innovation of this technique.

Summary of Findings

Ultrasonic tips preserved significantly more dentin, reinforcing the principle of **minimally invasive endodontics**.

Ultrasonic retrieval resulted in lower postoperative pain, supporting its role in **improving patient experience**.

Together, these outcomes highlight the **dual innovation** of the present study—integrating tooth conservation and patient comfort as complementary measures of clinical success.

4. DISCUSSION

Instrument fracture remains one of the most critical complications in contemporary endodontics, as it obstructs canal access, hinders disinfection, and threatens long-term prognosis if inadequately managed [10–12]. The clinician’s challenge is to decide whether to retain, bypass, or retrieve the fragment, always balancing the benefits of canal patency with the risks of excessive dentin loss.

Dentin Preservation as a Priority

The present study demonstrated that ultrasonic tips preserved significantly greater dentin thickness compared to the Masserann kit. This finding aligns with the principle highlighted by Lim and Stock [13], who emphasized that conserving dentin is essential to maintain tooth strength and resistance against vertical fracture. Excessive removal of root structure, as often required by the Masserann kit, weakens roots and predisposes them to perforation or catastrophic failure [14,17]. By contrast, ultrasonic retrieval enabled access with minimal sacrifice, directly supporting the paradigm of **minimally invasive endodontics**.

Patient-Centered Outcomes

Equally important, patients in the ultrasonic group reported significantly lower VAS pain scores than those in the Masserann group. Yang et al. [20] and Tzanetakis et al. [21] previously observed that excessive dentin removal and unnecessary canal enlargement increase postoperative discomfort and the risk of flare-ups. Our findings reinforce these observations, highlighting that ultrasonic techniques not only preserve tooth structure but also improve the patient’s overall treatment experience. This **dual evaluation of biological and patient-centered outcomes** represents the novel contribution of this research.

Anatomical and Clinical Considerations

The Masserann kit is traditionally recommended for straight canals, particularly in coronal and middle thirds, where access is less restrictive [17]. However, its application in curved or posterior canals is limited due to the large dentin sacrifice required. On the other hand, ultrasonic tips are particularly advantageous in such anatomies, as shown by Shen et al. [15] and Cujé et al. [22], because they allow precise and targeted retrieval under magnification. The present in vivo results confirm that ultrasonic systems provide a clinically superior and safer approach, especially in complex root anatomies.

Novelty of the Present Study

To the best of our knowledge, this is among the **first controlled in vivo trials** to simultaneously measure dentin preservation

and postoperative discomfort as co-primary outcomes in separated instrument retrieval. Previous investigations have primarily focused on retrieval success rates or technical feasibility [7–9,17]. By adopting a **dual-outcome framework**, our study introduces a new decision-making model: clinicians should evaluate retrieval techniques not only for technical efficacy but also for their impact on long-term tooth integrity and patient well-being.

Clinical Implications

The findings underscore the clinical value of ultrasonics in modern practice. By preserving nearly 40% more dentin and reducing postoperative discomfort, ultrasonic retrieval offers an evidence-based, minimally invasive, and patient-friendly solution. This dual advantage strengthens the argument for integrating ultrasonics as the **first-line approach in fractured instrument management**, especially in anatomically challenging situations.

5. CONCLUSION

This in vivo comparative study highlights a **novel dual-outcome framework** for evaluating fractured instrument retrieval techniques. By simultaneously measuring **residual dentin preservation** and **postoperative patient comfort**, the study demonstrates that ultrasonic tips are significantly superior to the Masserann kit. Ultrasonic retrieval not only conserved nearly 40% more dentin but also resulted in reduced postoperative discomfort, underscoring its role as a minimally invasive and patient-centered approach.

To the best of our knowledge, this is among the **first controlled clinical trials** to integrate both structural and patient-focused outcomes in endodontic retrieval research. These findings provide an **evidence-based rationale** for prioritizing ultrasonic techniques in clinical decision-making, particularly in anatomically complex cases where dentin conservation is paramount.

Clinical Significance

This study redefines clinical success in fractured instrument retrieval by **linking structural preservation with patient comfort**. Ultrasonic tips proved to be a **tooth-conserving and patient-friendly innovation**, shifting the clinical paradigm from mere technical success toward holistic, minimally invasive endodontics.

For practitioners, the findings support ultrasonic retrieval as the **preferred first-line technique**, offering long-term tooth strength, reduced patient morbidity, and alignment with modern endodontic principles.

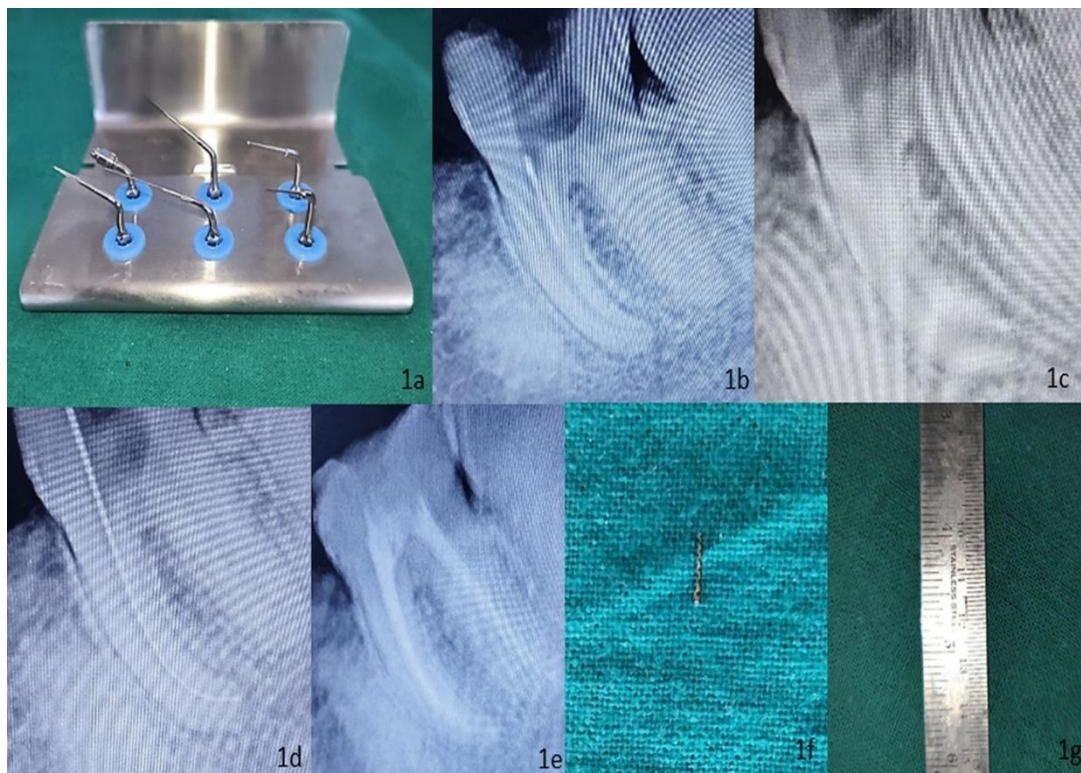


FIGURE 1 : 1a : Ultrasonic tips, 1b: Preoperative radiograph, , 1c : After removal of the fragment, 1d : Canal patency , 1e : After obturation, 1f and 1g : Retrieved file

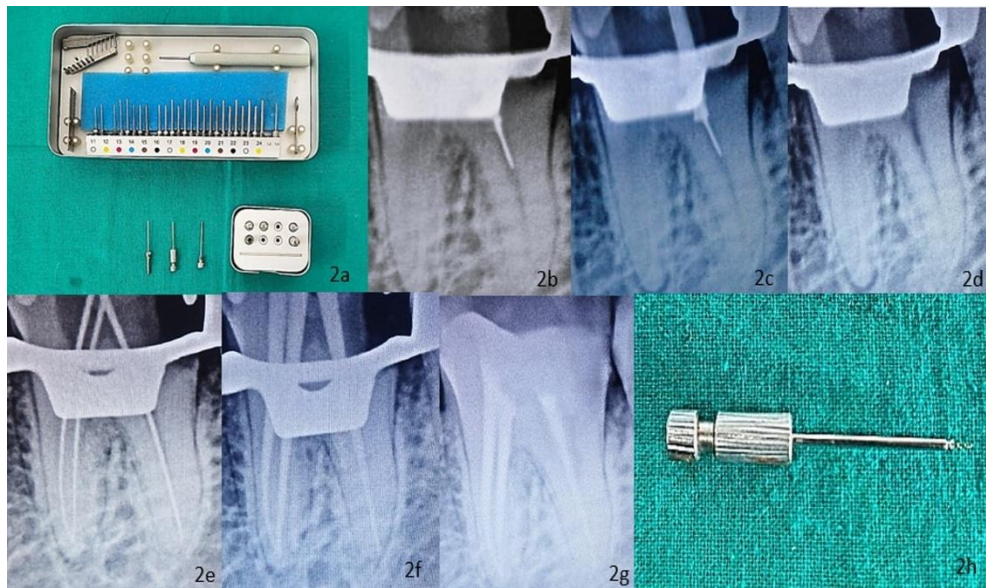


FIGURE 2 : 2a :Masserann kit, 2b: Preoperative radiograph, 2c : File engaged with Extractor, 2d : After removal of the fragment, 2e : Working length, 2f : Master cone, 2g : After obturation, 2h : File with extractor

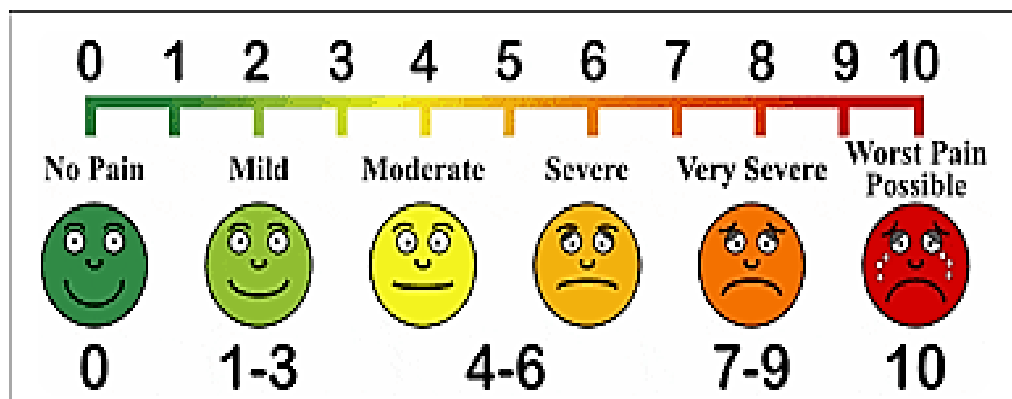
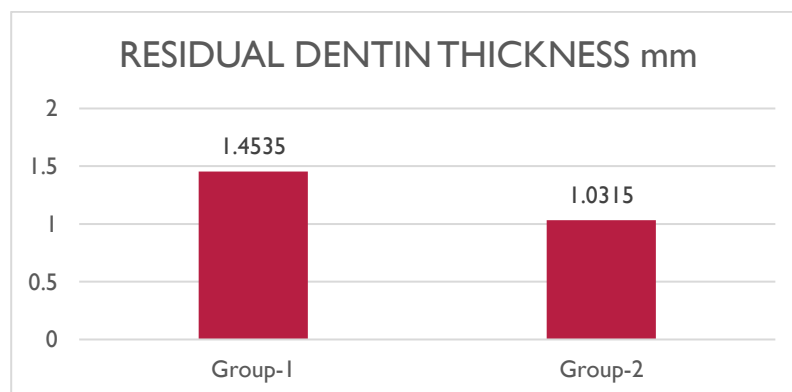
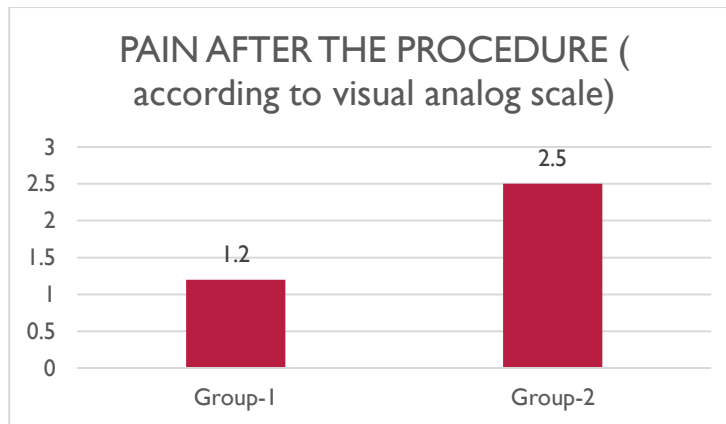


FIGURE : 3 Visual Analog Scale (VAS) was used as the primary method to measure pain intensity



GRAPH 1 - Intergroup Comparison of Residual Dentin Thickness



GRAPH 2 – Inter group Comparison of Pain After The Procedure (according to visual analog scale)

RESIDUAL DENTIN THICKNESS	SHAPIRO - WILK	
GROUPS	GROUP 1 (ULTRASONIC TIPS)	GROUP 2 (MASSERANN KIT)
P Value	0.063	0.003
Statistic	0.910	0.838

TABLE 1 - Table Showing Inter – group Comparison of Variables of Residual Dentin Thickness Using Shapiro – Wilk

Inter group comparison of values

Group	N	Mean	Std. Deviation	Mean Rank	Sum of Ranks	Median	Mann-Whitney U value	Z value	p value of Mann-Whitney U test
RESIDUAL DENTIN THICKNESS mm 1	20	1.45350	.100277	30.50	610.00	1.48	.000	-5.415	.000**
2	20	1.03150	.191374	10.50	210.00				

TABLE : 2 - Table Showing Inter – group Comparison of Residual Dentin Thickness - Mean, Std. Deviation, Mean Rank, Sum of Ranks, Median, Z value, P value using Mann – Whitney U test

PAIN AFTER THE PROCEDURE (ACCORDING TO VISUAL ANALOG SCALE)	SHAPIRO - WILK	
GROUPS	GROUP 1 (ULTRASONIC TIPS)	GROUP 2 (MASSERANN KIT)
P Value	0.000	0.055
Statistic	0.744	0.907

TABLE : 3 - Table Showing Inter – group Comparison of Variables of Pain After the Procedure (according to Visual Analog Scale) Using Shapiro – Wilk

Inter group comparison of values

Group	N	Mean	Std. Deviation	Mean Rank	Sum of Ranks	Median	Mann-Whitney U value	Z value	p value of Mann-Whitney U test
2	20	1.03150	.191374	10.50	210.00				
PAIN AFTER 1 THE PROCEDURE	20	1.20	1.196	15.70	314.00	2	104.000	-2.739	.006**
2 (according to visual analog scale)	20	2.50	1.606	25.30	506.00				

TABLE : 4 - Table Showing Inter – group Comparison of Pain After the Procedure (according to Visual Analog Scale) - Mean, Std. Deviation, Mean Rank, Sum of Ranks, Median, Z value, P value using Mann – Whitney U test

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