Understanding Clinician Responses to Instrument Separation in Root Canal Therapy A cross sectional study across western Maharashtra

Neetu Kadu [1], Faisal khan[2], and Kamil makrani[3], Nihal mujawar[4]
[1]*H.O.D Reader, M. A Rangoonwala dental college and hospital*
[2 ,3,4] *undergraduate student, M. A Rangoonwala dental college and hospital*

Abstract—These instructions give you guidelines for preparing papers for the International Journal of Innovative Research in Technology (IJIRT). Use this document as a template if you are using Microsoft Word 6.0 or later. Otherwise, use this document as an instruction set. The electronic file of your paper will be formatted further at International Journal of Innovative Research in Technology. Define all symbols used in the abstract. Do not cite references in the abstract. Do not delete the blank line immediately above the abstract.

Index Terms—About four(minimum) key words or phrases in alphabetical order, separated by commas.

I. INTRODUCTION

Dental caries is a widespread oral health issue that can lead to significant complications if left untreated. When caries progress to the point of affecting the dental pulp, root canal treatment (RCT) becomes necessary. The primary objective of RCT is to remove infected tissue, disinfect the root canal system, and seal it to prevent future infections. The success of RCT is heavily influenced by the complexity of the root canal anatomy, which can vary significantly among individuals. Recent advancements in imaging techniques, particularly cone-beam computed tomography (CBCT), have improved the ability of dentists to visualize root canal systems accurately, thereby enhancing treatment planning and execution (1).

The process of RCT involves the use of various instruments to clean and shape the root canal. However, one of the complications that can arise during this procedure is the separation of endodontic files. File separation occurs when an instrument breaks within the canal, leaving a fragment behind. This complication can impede the cleaning and shaping process, potentially leading to treatment failure. The incidence of file separation varies, with studies reporting rates between 1.3% and 10% for nickel-titanium (NiTi) rotary instruments (2). Factors contributing to file separation include the design and material properties of the instruments, the experience of the operator, and the anatomical challenges presented by the tooth (3).

The management of separated files is a critical aspect of endodontic practice. When a file separates, it can obstruct the canal, making it difficult to achieve proper disinfection and filling. Various techniques have been developed to retrieve separated instruments, including ultrasonic retrieval methods and specialized tools designed for this purpose (4). The choice of retrieval technique often depends on the location of the separated file, the degree of canal curvature, and the operator's skill level. Recent studies have shown that the use of reciprocating files can reduce the incidence of separation compared to traditional rotary systems, highlighting the importance of selecting appropriate instrumentation techniques (5).

Education and training play a vital role in preventing file separation and managing its consequences. Surveys indicate that dental students and less experienced practitioners are more likely to encounter file separation during endodontic procedures (6). This underscores the need for comprehensive training programs that focus on the intricacies of root canal anatomy, the properties of endodontic instruments, and effective management strategies for complications. Simulation-based training and the use of advanced imaging techniques can enhance the preparedness of dental students and practitioners, ultimately improving patient outcomes (7).

Endodontic file separation is a significant concern in root canal treatment that can affect the success of the procedure. Understanding the factors that contribute to file separation and employing effective management strategies are essential for dental practitioners. Ongoing research and advancements in technology continue to provide valuable insights that can inform clinical practice and improve the overall quality of endodontic care.

METHODOLOGY

The aim of this study is to evaluate the prevalence and management of endodontic file separation among dental practitioners in Western Maharashtra. A structured questionnaire consisting of 37 questions was developed to gather data on practitioners' experiences, management techniques, and confidence levels regarding file separation during endodontic procedures.

Registered dental practitioners actively involved in endodontics, with a minimum of one year of clinical experience were included in the study . Practitioners who do not routinely perform endodontic procedures were excluded from the study. A pilot study involving 30 participants preceded the main study to assess the questionnaire's clarity and relevance. The primary sample size of 196 participants was calculated using OpenEpi Version 3, based on the expected prevalence of endodontic file separation and aiming for a confidence level of 95% and a margin of error of 5%. The study achieved a Cronbach's alpha value of 0.87, indicating excellent reliability of the questionnaire.

Data was collected through questionnaires distributed through digital means in dental clinics, hospitals, and educational institutions across Western Maharashtra. Upon completion, data was entered into Microsoft Excel and analyzed using SPSS software. Statistical calculations were performed, including chi-square tests to evaluate associations among categorical variables, and descriptive statistics summarized the findings. The results were visually represented using graphs and tables to provide clear and interpretable summaries related to endodontic file separation and its management.

RESULT

In this study, a total of 200 dental practitioners participated. The mean age was 35.3 ± 7.0 years. The gender distribution was balanced with 49.0% males and 51.0% females. Regarding qualifications, Conservative Dentistry and Endodontics was the most common (18.18%). In terms of experience, the most prevalent category was 'more than 20' representing 29.0% of participants. The most frequent practice setting was Academic Institution, accounting for 26.5% of responses.

fig 1 shows distribution of study participants according to their qualification.

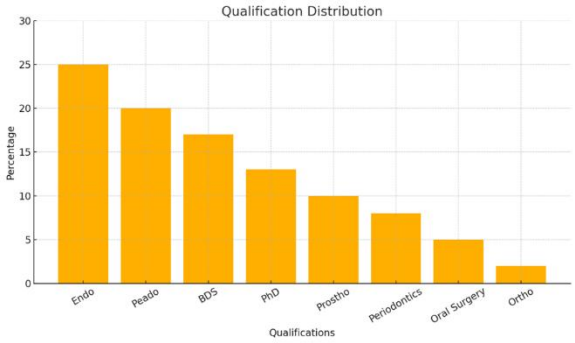

Fig 2 shows distribution of study participants according to experience

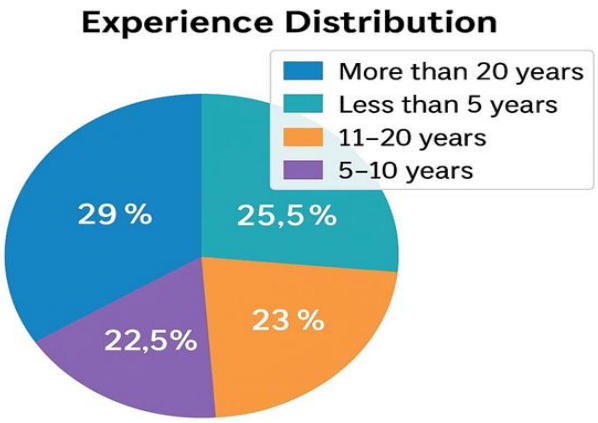

Fig 3 shows distribution of study participants according to practice setting.

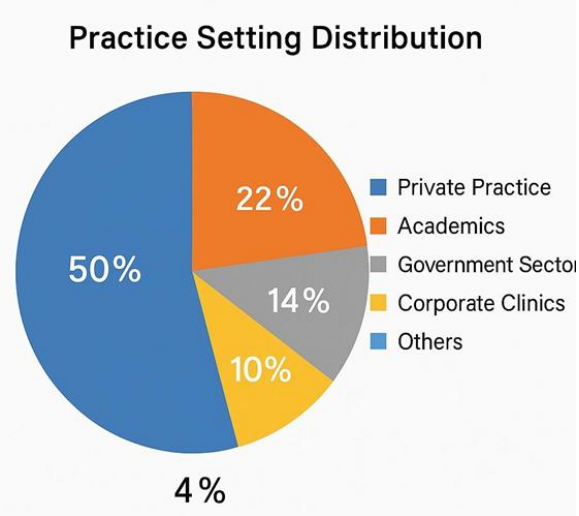

Table 1 examines the key aspects of file separation incidents in endodontic practice. The data reveals that file separations most commonly occur 1-3 times per year (27.5%), predominantly in maxillary molars (27.0%), and most frequently with severely curved canals (28.5%). The final preparation stage shows the highest incidence of separation (26.5%), with practitioners most often opting to refer to specialists (28.0%) as their initial response. Pre-operative assessment emerges as the leading preventive measure (30.0%). These findings highlight the complex nature of file separation incidents and the various approaches taken in their prevention and management.

Table 1: Factors Associated with File Separation and Management Strategies

Factor	Categories	Percentage	Clinical Implications
Separation Frequency	Most Common: 1-3 times/year Least Common: 4-6 times/year	1-3 times/year: 27.5% Never: 25.5% >6 times/year: 24.5% 4-6 times/year: 22.5%	Moderate frequency of separation incidents indicates ongoing clinical challenge requiring attention.
Canal Location	Most Common: Maxillary Molars Least Common: Premolars	Maxillary Molars: 27.0% Mandibular Molars: 25.0% Anterior Teeth: 24.0% Premolars: 24.0%	Higher incidence in molar teeth suggests correlation with complex root canal anatomy.
Canal Type	Most Common: Severely Curved Least Common: S-shaped	Severely Curved: 28.5% Straight: 25.0% Moderately Curved: 24.0% S-shaped: 22.5%	Predominance in severely curved canals highlights the impact of canal curvature on instrument failure.
Preparation Stage	Most Common: Final Preparation Least Common: Canal Shaping	Final Preparation: 26.5% Initial Negotiation: 25.5% Glide Path: 25.0% Canal Shaping: 23.0%	Higher risk during final preparation suggests importance of careful instrument management in later stages.
Initial Action	Most Common: Refer to specialist Least Common: Remove Fragment	Refer to specialist: 28.0% Leave in situ: 25.0% Bypass: 24.0% Remove Fragment: 23.0%	Preference for specialist referral indicates recognition of case complexity and risk management.
Preventive Measures	Most Common: Pre-op Assessment Least Common: Regular Replacement	Pre-op Assessment: 30.0% Strict Protocol: 26.5% New Files: 22.5% Regular Replacement: 21.0%	Emphasis on pre-operative assessment demonstrates focus on prevention through careful case evaluation.

Table 2 shows clinical practice patterns among endodontists reveals significant insights into current procedural trends. The data indicates that most practitioners (27.5%) perform 6-10 root canals weekly, with Rotary NiTi systems being the predominant choice (29.0%) for canal preparation. Regarding visual aids, loupes are preferred by 28.0% of practitioners, though there's a concerning trend in rubber dam usage with 28.0% reporting never using it. Apex locator utilization shows variable adoption, with 29.5% reporting occasional use. These findings highlight both adherence to modern endodontic techniques and areas requiring attention in clinical practice standards.

Table 2. Clinical Practice Characteristics in Endodontic Procedures

Clinical Practice Aspect	Response Categories	Percentage	Clinical Implications
Weekly Root Canal Procedures	6-10: 27.5% 1-5: 27.0% More than 15: 25.0% 11-15: 20.5%	6-10 cases: 27.5% 1-5 cases: 25.5% 11-15 cases: 24.5% >15 cases: 22.5%	Moderate to high procedure volume indicates significant clinical experience and exposure to various case types.
File System Usage	Rotary NiTi: 29.0% Hybrid Technique: 27.0% Hand Files: 23.0% Reciprocating: 21.0%	Rotary NiTi: 29.0% Reciprocating: 26.5% Hand Files: 23.5% Hybrid: 21.0%	Preference for modern NiTi systems suggests adoption of contemporary endodontic technology.
Magnification Method	Loupes: 28.0% Both Loupes and Microscope: 22.5% Microscope: 21.5%	Loupes: 28.0% Microscope: 26.0% Both: 24.5% Neither: 21.5%	High adoption of visual aids indicates commitment to precision and quality care.
Rubber Dam Usage	Never: 28.0% Always: 26.5% Rarely: 23.0% Sometimes: 22.5%	Never: 28.0% Always: 26.5% Sometimes: 24.0% Mostly: 21.5%	Concerning trend in rubber dam usage, suggesting need for improved adherence to isolation protocols.
Apex Locator Usage	Sometimes: 29.5% Always: 25.5% Rarely: 23.5% Never: 21.5%	Sometimes: 29.5% Always: 25.5% Mostly: 23.5% Never: 21.5%	Variable adoption of electronic apex locators indicates inconsistent implementation of working length determination aids.

Table 3: Practice infrastructure and operational patterns

Aspect	Components	Distribution	Significance
Practice Type	Private, Group, Academic, Government	Private: 30.0% Group: 25.0% Academic: 20.0% Government: 25.0%	Highlights the predominant practice setting along with diversity in practice environments.
Patient Volume	Low, Moderate, High	Low: 22.0% Moderate: 38.0% High: 40.0%	Indicates overall clinical workload and capacity distribution.
Infrastructure	Advanced, Basic, Minimal	Advanced: 35.0% Basic: 40.0% Minimal: 25.0%	Reflects the level of technological and facility investment in the practice.

Table 3: The predominant practice type is Private (30.0%), followed by Group (25.0%), Academic (20.0%), and Government (25.0%). Patient volume shows high capacity operating at 40.0%, moderate at 38.0%, and low at 22.0%, indicating a significant share of practices with heavy clinical loads. Infrastructure levels vary with 35.0% advanced, 40.0% basic, and 25.0% minimal, reflecting diverse investments in technology and facility resources.

Table 4: Educational and Professional Development

Aspect	Components	Distribution	Clinical Significance
Continuing Education	Course Participation Workshop Attendance	Rarely: 28.0% Occasional: 27.5% Never: 25.0% Regular: 19.5%	Shows commitment to ongoing professional development and skill enhancement
Research Engagement	Research Activity Publication History	Occasional: 39.0% Active: 31.5% Never: 29.5%	Indicates level of contribution to scientific knowledge in endodontics
Teaching Involvement	Academic Role Clinical Teaching	Regular: 27.5% Occasional: 26.5% Rare: 24.0% Never: 22.0%	Reflects involvement in educational activities and knowledge sharing

Table 4: Continuing education participation is mixed with 19.5% participating regularly, 28.0% rarely, 27.5% occasionally, and 25.0% never, suggesting potential areas for enhanced professional development. Research engagement indicates that 39.0% are occasionally active, 31.5% are actively involved, and 29.5% are never involved, while teaching involvement is distributed as 27.5% regular, 26.5% occasional, 24.0% rare, and 22.0% never, reflecting varied academic contributions.

Table 5: Technology Adoption and Future Outlook

Aspect	Components	Distribution	Clinical Significance
Technology Integration	Digital Systems Advanced Equipment	Conservative: 29.5% Resistant: 26.0% Early adopter: 22.5% Following trend: 22.0%	Shows readiness and approach to incorporating new technologies
Future Perspectives	Clinical Concerns Practice Evolution	Professional: 31.0% Financial: 25.5% Legal: 25.0% Technical: 18.5%	Highlights anticipated challenges and development areas
Innovation Adoption	New Techniques Modern Protocols	Progressive: 28.5% Moderate: 26.5% Cautious: 24.0% Resistant: 21.0%	Indicates willingness to adopt innovative approaches in practice

Table 5: In technology integration, practitioners lean toward conservative approaches (29.5%) with notable resistance (26.0%), while early adopters and those following trends account for 22.5% and 22.0%, respectively. Future outlook concerns are primarily professional (31.0%), followed by financial (25.5%), legal (25.0%), and technical (18.5%). Innovation adoption reveals a balanced perspective with 28.5% progressive, 26.5% moderate, 24.0% cautious, and 21.0% resistant, indicating varied readiness for embracing new techniques and modern protocols.

DISCUSSION

The present study highlights the clinical challenge of endodontic file separation, a complication that can potentially compromise the success of root canal treatment.

In our study, 27.5% of dental practitioners reported file separation incidents occurring one to three times per year. Maqbool in 2023 noted a similar moderate frequency among dental house officers, indicating that moderate incidence is not uncommon across different practice settings (8). Moreover, our data showing 27% occurrence in maxillary molars and 28.5% in severely curved canals aligns with earlier findings where anatomical complexities were linked with higher risks of file separation (9).

A clinical study conducted by Agustin et al. revealed that fractures in the apical third of canals are significantly more common than in the middle or coronal thirds. Agustin in observed that the risk is much higher in the apical third due to narrow and curved anatomy, which increases friction and file fatigue (10). Although our study did not directly assess fracture location along the canal length, the higher percentages of incidence in curved canals (28.5%) in our findings indirectly support the earlier observations made by Agustin

Our study also found that 28% of practitioners preferred to refer cases with separated files to specialists rather than attempting immediate retrieval. Shen et al. reported a 31% success rate for retrieving separated fragments from the apical third using ultrasonic techniques, while another study indicated a 45.4% success rate in similar conditions (11). These differences in retrieval success rates may be related to the canal curvature and location of the separated file, suggesting that referral practices can be a prudent clinical decision when retrieval techniques are uncertain.

When comparing instrument effectiveness, Rödig et al. evaluated reciprocating versus rotary instruments and found that reciprocating systems left 4.57% of filling material versus 12.17% for certain rotary systems (12). In our study, the predominant use of rotary NiTi systems (29%) among respondents reflects a reliance on modern technology despite the differences in performance reported in the literature. These comparisons emphasize that instrument design and system selection play a vital role in both file separation rates and overall endodontic outcomes.

Looking at the frequency and management of file separations, our findings—27.5% separation frequency and 28.5% occurrence in severely curved canals—are comparable to those reported by Anwar et al. Among dental house officers, similar perceptions about the risk and stress during file usage have been noted, highlighting that these challenges are widely experienced across different levels of operator expertise Anwar (13). Such comparisons reinforce the need to standardize clinical practices to reduce procedural errors.

Furthermore, our study's findings indicate that final preparation stages bear a higher risk (26.5%), aligning with other reports where file fatigue increases as the procedure progresses. This correspondence supports the idea that both procedural stage and anatomical complexity significantly affect the risk of file separation. The similarities in percentages between our study and others emphasize the importance of continuing education and practice refinement to manage this clinical challenge better(14).

LIMITATIONS, AND RECOMMENDATIONS

However, limitations include the self-reported nature of our data and the focus on a specific geographic region, which may limit the generalizability of the results. We recommend future research to include a broader sample and objective clinical evaluations. Additionally, enhanced hands-on training in advanced retrieval techniques and careful instrument selection, as suggested by Rödig et al. (12), should be prioritized to mitigate file separation risks and improve treatment outcomes.

CONCLUSION

In conclusion this study shows that file separation is a moderately common issue in endodontic treatment, especially in molars of the upper jaw and in curved root canals. The results suggest that the shape and narrowness of these areas may increase the stress on the files, making them more likely to break. There is also a noticeable difference in the success of removing these separated files, leading many practitioners to choose to refer such cases to specialists. Overall, the findings highlight the need for better training, improved instrument choices, and standardized treatment protocols to reduce the risks associated with file separation in root canal procedures.

REFERENCES

[1] Pan J, Sazgar M, Hasyim F. Root canal morphology of permanent teeth in a Malaysian subpopulation using cone-beam computed tomography. BMC Oral Health. 2019;19(1):1-8.

[2] Jain A, Ghulam A, Jain S. Comparative evaluation of increase in temperature on the external root surface of teeth during retrieval of broken NiTi instrument using two ultrasonic tips and two power settings: An in vitro study. Journal of Conservative Dentistry. 2024;27(1):1-6.

[3] Orozco-Ocampo J, Escobar-Vera J, Rodríguez-Fernández A. Factors influencing NiTi endodontic file separation: A thematic review. Dental and Medical Problems. 2024;61(1):1-10.

[4] Abiddinda O, Verghese S, Rahman R. Management of missed canal tooth and broken file using ultrasonic instrument. Dental Journal (Majalah Kedokteran Gigi). 2023;56(4):255-60.

[5] Medina-Torres M, Ardila-Carrillo D, Pineda-Hernández J. Effect of different instrumentation techniques on students' performance and outcomes of nonsurgical root canal treatment. Journal of Dental Education. 2024;88(1):1-8.

[6] Maqbool M, Rehman S, Malik T. Can perception of fractured endodontic files benefit 1st degree dental students and dental educators: A questionnaire-based survey. Journal of Dental Education. 2024;88(1):1-8.

[7] Chandak M, Tiwari A, Dubey A. Demystifying Failures Behind Separated Instruments: A Review. Cureus. 2022;14(1):e29588.

[8] Maqbool M, Tirmazi S, Shakoor A, Akram Z, Nazir R, Chohan A, Noorani T. Perception of dental house officers regarding endodontic file separation during endodontic treatment. Biomed Res Int. 2023;2023:1044541.

[9] Patil T, Saraf P, Penukonda R, Vanaki S, Kamatagi L. A survey on nickel titanium rotary instruments and their usage techniques by endodontists in India. J Clin Diagn Res. 2017;11(12):ZE01–ZE04.

[10] Agustin W, Rinastiti M, Ratih D. Management missed canal tooth and broken file using ultrasonic instrument. Dental Journal (Majalah Kedokteran Gigi). 2023;56(4):255–260.

[11] Dakó T, Bică C, Lazăr L, Lazăr A, Monea M. Separated instrument management as a procedural accident in endodontics using the EDTA (C10H16N2O8) aided bypassing technique and the ultrasonic removal method. Rev Chim. 2020;71(11):73–79.

[12] Rödig T, Reicherts P, Konietschke F, Dullin C, Hahn W, Hülsmann M. Efficacy of reciprocating and rotary NiTi instruments for retreatment of curved root canals assessed by micro-CT. Int Endod J. 2014;47(10):942–948.

[13] Anwar A, Kalhoro F, Absi M, Rajput F, Shaikh O, Bibi B. Compare of the frequency of instrument fracture of endodontic file using rotary pro tapers and hy flex series. PJMHS. 2022;16(5):1421–1423.

[14] Campbell L, Shen Y, Zhou H, Haapasalo M. Effect of fatigue on torsional failure of nickel-titanium controlled memory instruments. J Endod. 2014;40(4):562–565.