


Endodontic file separation and its management among dentists in Punjab, Pakistan: a cross-sectional study

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Aim: The study aimed to find the incidence and awareness of endodontic instrument separation and its management among dental house officers, postgraduate trainees, demonstrators, consultants, and general dentists. **Methods:** This online questionnaire-based cross-sectional study was conducted with the approval of the IRB in private and public dental hospitals and dental clinics in Punjab. The authors developed the survey tool, which comprises 24 closed-ended items regarding demographics, the incidence of file separation, and awareness about its management. The data were analyzed using IBM SPSS version 24. The Chi-Square Test was used to compare percentages of categorical variables. **Results:** Postgraduate trainees experienced the most instrument separations (43.6%), made the most retrieval attempts (49.2%), and experienced the most secondary errors during retrieval (52.1%) ($p < 0.001$). Around four out of ten respondents always informed the patients (39.6%) and department (41.6%) about errors. Manual files (69.8%), stainless steel files (75.8%), and short files (60.4%) were more frequently separated, and the most frequent cause was older fatigue files (57.7%). Manual files were more frequently broken in public dental institutes ($p = 0.003$). Two-thirds of the file separations (72.5%) occurred during cleaning and shaping in the apical third of molars (65.1%), especially in mesiolingual canal (56.4%). Bypass attempt was the most common in symptomatic teeth (47.7%). **Conclusions:** Preventive approaches such as limiting file reuse and constructing a glide path can reduce the occurrence of file separation. Operators should be familiar with the number of uses of the instrument before fatigue and should be trained through workshops and refresher courses.

Keywords: Dentists. Endodontists. Pakistan. Prevalence.

Introduction

Eight out of ten dentists have experienced endodontic file fracture at some point in their clinical career, especially in the posterior dentition^{1,2}. File separation is an unfortunate, challenging event that may impede an endodontic treatment and lead to failure, depending on the stage, type, and location of file breakage. Various risk factors that can cause instrument separation include severely curved canals, older-fatigued files, inexperience, wrong motion, manufacturing flaws, excessive force, and not following the manufacturer's guidelines³⁻⁵.

A mishap like an instrument separation can be managed conservatively or surgically based on the severity of the case, patients' compliance, and operators' proficiency. The Conservative approach involves bypassing the fragment, removing the fragment, or sometimes keeping the fragment along with the obturation in case there is no residual infection^{6,7}. The fate of the teeth with a broken instrument depends on bacterial load, the stage at which the instrument got separated, periapical lesion, and final obturation⁸.

Many techniques and systems have been developed for the removal of separated instruments. The most efficient and reliable are ultrasonic instruments and dental optical microscopes^{5,9}. Other Instrument Retrieval systems (IRS), also known as tube-like systems, are technique-sensitive, require excessive dentin removal to expose the coronal part of the fragment, and pose a risk of perforation^{6,10}. These systems include the Endo-Extractor system, Masserann kit, Cancelier instrument, and Mounce extractor^{11,12}. While modern endodontic files are designed to be strong and durable, file separation can still happen. The implementation of strategies to prevent instrument separation, the efficient handling of incidents when they occur, and familiarity with different retrieval methods not only decrease the occurrence of separation but also save time and improve treatment outcomes^{4,10}.

This study aimed to find the incidence and awareness of endodontic instrument separation and its management among dental house officers, postgraduate trainees, demonstrators, and consultants working in dental institutes in Punjab. Understanding the incidence and management of instrument fracture in endodontics is crucial for both dental practitioners and patients as it will improve the quality of endodontic treatment, reduce the risk of complications, and reduce the financial burden and inconvenience associated with additional treatments.

Methods

This descriptive cross-sectional study was conducted from December 20th, 2021, to December 13th, 2022, after the approval of the Institutional Review Board (IRB) of the Institute of Dentistry, CMH Lahore Medical College (649/ERC/CMH/LMC), and with the permission of the participating institutes. Informed consent was obtained, and the confidentiality statement was stated in the questionnaire. Questionnaires were distributed online among dentists, including demonstrators, postgraduate trainees, house officers, and consultants working in the operative departments of five private and two public dental institutes in Punjab, through purposive sampling using

email and WhatsApp. Dental graduates who were not part of the operative clinics, undergraduates in the dental clinics, and those who did not give consent were not included in the study.

The questionnaire was developed by the authors and consisted of 24 closed-ended questions. The first part targeted demographics such as age, gender, institute, designation, and years of experience. The second part of the questionnaire dealt with the incidence of endodontic file separation as well as the awareness and attitude of dentists towards it and their understanding of management options. The questionnaire underwent several revisions before the draft was finalized, which underwent face and content validity through expert review.

The data were analyzed using the IBM Statistical Package for Social Sciences (SPSS version 24, IBM Corporation). Descriptive statistics were employed to tabulate the percentages and frequencies of the variables. The Chi-Square Test was used to compare the categorical variables. A p-value less than or equal to 0.05 was taken as significant.

Results

In the present study, 160 individuals were approached, and 149 respondents responded to the questionnaire; the response rate was 93.1%. The demographics have been expressed in Table 1.

Table 1. Demographical information of the participants

Demographics		n	%
Gender	Male	59	39.6
	Female	90	60.4
Institute	Private	83	55.7
	Public	66	44.3
Designation	House Officer	46	30.9
	Post Graduate Trainee	47	31.5
	Demonstrator	27	18.1
	Consultant	29	19.4
Years of Experience	Less than 2 years	55	36.9
	2 to 5 years	56	37.6
	More than 5 years	38	25.5

The frequency of endodontic instrument separation was 69.1% (n=103), the attempt of retrieval/bypass was 44.9% (n=67), and the occurrence of a secondary error during the retrieval/bypass was 47.6% (n=71).

The frequency of file separation, retrieval attempt, and secondary error during retrieval or bypass among different designations have been illustrated in Figure 1. There was a significant difference between the house officers, postgraduate trainees, demonstra-

tors, and consultants pertaining to the file separation ($X^2=50.7$, $p<0.001^*$), retrieval attempt/bypass ($X^2=26.3$, $p<0.001^*$) and the occurrence of secondary file separation during retrieval/bypass ($X^2=35.1$, $p<0.001^*$). Postgraduate trainees experienced the most instrument separations ($n=45$, 43.6%), made the most retrieval attempts ($n=33$, 49.2%), and experienced the most secondary errors during retrieval ($n=37$, 52.1%), followed by consultants, demonstrators, and house officers (Figure 1).

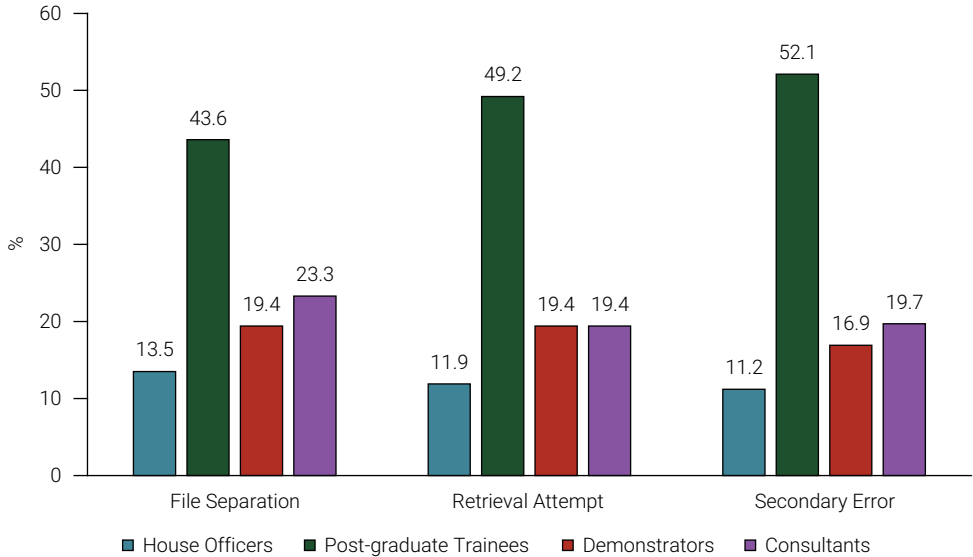


Figure 1. Frequency of endodontic file separation experience, retrieval attempt, and secondary error during retrieval or bypass

Most respondents showed a positive perception when it came to informing patients and departments about the file separation (Table 2).

Table 2. Informing patients and department about the endodontic file separation incident

	Always n(%)	Sometimes n(%)	Rarely n(%)	Never n(%)
Informing the patient	59 (39.6)	45 (30.2)	14 (9.4)	31 (20.8)
Informing the department	62 (41.6)	55 (36.9)	16 (10.7)	16 (10.7)

The comparison between private and public dental institutes regarding frequency of endodontic file separation, type of file separated, length of file, and cause of separation have been expressed in Table 3. Manual endodontic files were more frequently broken in public dental institutes ($p=0.003$). However, there was no difference reported regarding the occurrence of instrument separation ($p=0.519$), manufacturing type ($p=0.29$), file length ($p=0.322$), and cause of separation ($p=0.496$) (Table 3).

Table 3. Comparison between private and public dental institutes regarding frequency of endodontic file separation, file type, length, and causes of separation

Variables		n(%)	Private (n)%	Public (n)%	X ²	p
Occurrence of File Separation	Yes	103 (69.1)	57 (68.6)	46 (69.7)	0.018	0.519
	No	46 (30.9)	26 (31.3)	20 (30.3)		
File Type	Manual	104 (69.8)	50 (60.2)	54 (81.8)	8.12	0.003
	Rotary	45 (30.2)	33 (39.7)	12 (18.1)		
Manufacturing Type	Stainless Steel	113 (75.8)	61 (73.4)	52 (78.7)	0.562	0.290
	Nickle Titanium	36 (24.2)	22 (26.5)	14 (21.2)		
File Length	Short	90 (60.4)	52 (62.6)	38 (57.5)	0.396	0.322
	Long	59 (39.6)	31 (37.3)	28 (42.4)		
Cause of File Separation	Older fatigued files	86 (57.7)	50 (60.2)	36 (54.5)	3.38	0.496
	Improper motion	29 (19.5)	13 (15.6)	16 (24.2)		
	Complex canal anatomy	19 (12.8)	13 (15.6)	6 (9)		
	Calcified canals	9 (6.0)	4 (4.8)	5 (7.5)		
	Inexperience	6 (4.0)	3 (3.6)	3 (4.5)		

The frequencies of instrument separation at different stages of root canal treatment, susceptible teeth, susceptible canal, and the part of root canal have been tabulated in Table 4.

Table 4. Frequency of endodontic instrument separation at different stages, parts of the canal, as well as susceptible teeth and canal

Variables		n	%
Stage of Root Canal	Cleaning and shaping	108	72.5
	During Negotiating	41	27.5
Part of Canal	Apical	97	65.1
	Middle	50	33.6
	Coronal	2	1.3
Susceptible Teeth	Molar	132	88.6
	Premolar	7	4.7
	Canine	6	4.0
	Incisor	4	2.6

Continue

Continuation			
Susceptible Canal	Mesiolingual	84	56.4
	Mesiobuccal	81	54.4
	Distolingual	11	7.4
	Distal	9	6
	Palatal	9	6
	Distobuccal	8	5.4

The management of instrument separation in the case of the symptomatic and non-symptomatic teeth is shown in Table 5. The management of separated endodontic files, their retrieval technique used, and the presence of an instrument retrieval system in the departments are expressed in Table 6.

Table 5. Management in case of instrument fracture in a symptomatic and non-symptomatic tooth

Variables	Non-Symptomatic Tooth n(%)	Symptomatic Tooth n(%)
Complete treatment with fragment inside	65 (43.6)	21 (14.1)
Bypass of fragment	58 (38.9)	71 (47.7)
Removal of fragment	6 (4.0)	13 (8.7)
Refer to endodontist	16 (10.7)	29 (19.5)
Refer to the surgery department	4 (2.7)	15 (10.1)

Table 6. Management of endodontic file separation, retrieval technique used, and instrument retrieval system present in the department

Variables	n	%	
Management of file separation	Bypass Attempt	106	71.1
	Retrieval Attempt	67	45
Retrieval Technique Used	Ultrasonics	46	30.9
	IRS (Instrument Retrieval Kit)	6	4.0
	Wire-loop technique	19	12.8
Instrument Retrieval System in Department	No System	113	75.8
	Ultrasonics	14	9.4
	IRS (Instrument Retrieval Kit)	14	9.4
	Wire-loop technique	8	5.4

Discussion

Modern endodontics witnesses a plenitude of progress resulting from continuous scientific innovations and development in technologies, techniques, and resources.

The present study entails identifying all the contributing factors and highlighting the necessity of developing proper parameters to avert the occurrence of such challenging situations^{12,13}.

The results of the present study reported the highest incidence of file separation amongst postgraduate trainees (43.6%), which is in agreement with the previous literature^{13,14}. The higher incidence of file separation among postgraduates and endodontists can be explained by the higher number of endodontic cases as well as complex cases performed per week. On the contrary, Pedir et al.¹⁵ (2016) found that general dentists had the highest prevalence of instrument separation compared to dental students working in clinics. Dental students and house officers may have a lower incidence of instrument separation and adverse outcomes, as they are usually assigned simpler, less complicated cases.

It can be very challenging to ascertain the incidence of file fractures as a substantial number of clinical cases get overlooked due to flawed reporting. The fundamental legal and ethical dental code urges the operator to notify the patient and the department about instrument separation and prognosis. In the present study, most of the participants informed patients as well as their departments. The results were in accordance with previous studies¹⁶⁻¹⁸.

A significant proportion of the file separation cases in the present study were from private dental hospitals, with manual stainless files of shorter lengths being more frequently separated. These results were consistent with the study conducted by Pedir et al.¹⁵ (2016). However, these results were against the authors' expectations, as private dental institutes in Pakistan are better developed, well-funded, and technologically advanced. The operators in public dental institutes may experience a much higher flow of patients and hence have more experience, leading to fewer events of instrument fracture¹.

Recent literature suggests a higher incidence of rotary NiTi instrument separation as they are frequently subjected to a combination of torsional and cyclic stresses, especially at higher speeds¹⁹. The conflicting results between the present study and the literature can be explained by the recent shift to the newer NiTi file system and its more frequent use²⁰. The fracture of stainless-steel files is generally attributed to overuse, as reported by the majority (57.7%) of the participants of the present study. Since 2007, The Department of Health in the United Kingdom has mandated that all endodontic files are for single-use. However, no such regulation exists within other European jurisdictions, and the number of times an instrument is used varies with the operator. Presently, providing a definitive guideline to propose a safe number of uses is challenging, but it is accepted that files should be discarded after signs of distortion²¹.

Most of the literature identifies that most instruments fractured in the apical third of the canal due to its maximum curvature and smallest diameter^{2,3,6}. Similar results were found in the present investigation. The higher incidence of fracture during cleaning and shaping can be attributed to the failure to obtain straight-line access and ineffective endodontic irrigation.

Separation of instruments in the later stages of instrumentation of an aseptic canal has shown a better prognosis. The literature suggests instrumentation and obturation of the canal coronal to the retained instrument with regular follow-up. A similar trend was reported in the present study. However, a bypass or retrieval attempt is advocated in symptomatic cases or cases with periapical lesions, as practiced by 47.7% of the participants of the present study^{6,10}.

Most respondents chose to bypass retrieval as their treatment option because it is believed to be the safest and the least invasive treatment path. In contrast, retrieval is a rather challenging procedure, as mentioned in the previous literature. Moreover, ultrasonics with a dental operating microscope is considered the most successful method for instrument removal among various devices and techniques described in the literature^{9,10,14,15}. Most of the participants in the present study would also use ultrasonics to retrieve the broken fragment.

Around three-fourths (75.8%) of the respondents reported an absence of the instrument retrieval system in their department. Although no certified instructions have been published concerning the treatment of instrument separation, it is recommended to initially aim at bypassing the separated fragment because this has been proved to be a more conservative approach. However, where bypassing is hopeless, retrieval of the fragment is advised. A retained separated instrument in a symptomatic tooth can compromise the prognosis of the tooth and even necessitate further interventions such as surgical endodontics or tooth extraction, as stated by Gandevala et al.²² (2014), and Maqbool et al.²³ (2023).

In conclusion, Endodontic file separation remains a challenging issue in dental hospitals. Postgraduate trainees and consultants reported a higher incidence of file separation, especially in manual, stainless steel, and shorter files, and preferred keeping the separated instrument inside, unless the tooth was symptomatic. The operators must be trained through seminars and refresher courses. Preventive measures, such as limiting file reuse and raising awareness of the number of times an instrument can be used before fatigue sets in, can reduce the occurrence of separation and can significantly influence the overall patient experience and clinical outcomes.

Conflict of Interest

The authors declare no conflicts of interest.

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Data Availability

Datasets related to this article will be available to the corresponding author upon request.

Author Contribution

All authors have actively participated, at least, in two distinct criteria about the authorship and. have revised and approved the final version of the manuscript. Specific contributions made by each author are given below:

Dr. Hammad Hassan: Conception and design, drafting of the article, interpretation of data, statistical analysis.

Dr. Syed Moiz Ali: Conception and design, collection of data, drafting of article.

Dr. Baneen Khawar: Drafting of manuscript, critical revision, data interpretation.

Dr. Sidra Riaz: Data collection, drafting of manuscript, data interpretation.

Dr. Razia Zia: Data interpretation, data collection, proof reading.

Dr. Marij Hameed: Critical revision, data collection.

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