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Ethical Perspectives and Attitudes of Dentists Towards Endodontic Instrument Fracture: A Cross-Sectional Study in Iran

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Abstract

Objective(s): Fracture of endodontic instruments is a common procedure complication with significant ethical implications. The attitudes and judgments of dentists concerning the disclosure and handling of such incidents are essential for ethical practice and patient trust. **Methods:** A cross-sectional study was performed alongside 361 dental practitioners across the country, utilizing a validated questionnaire to evaluate ethical conduct and regards concerning fractured endodontic instrument. Data were statistically analyzed using the chi-square test at a 5% significant threshold. **Results:** Among the participants, 85% experienced fractured instrument. Only 41.7% stated that they informed the patient when such an mishap occurred. Among cases with a good prognosis, 52.9% chose to complete treatment without informing the patient. In cases with a poor prognosis, 54.9% informed the patient and referred them to a specialist. Endodontists demonstrated more ethically aligned responses in some scenarios ($p < 0.05$). **Conclusion:** A significant portion of dentists are reluctant to report fractured instrument, particularly in situations with a positive prognosis. This underscores the necessity for enhanced ethical training and consistent protocols regarding patient communication and mishap management.

Keywords: Ethics; Endodontics; Root Canal Therapy; Treatment Failure; Complications

Introduction

Despite recent progress in root canal treatment (RCT) techniques, reported cases of errors and negligence have increased, with instrument fracture inside the canal being one of the most common complications[1-4]. Fractured instrument may impact the treatment by affecting the prognosis, complicating canal disinfection, and potentially reducing healing in specific cases [5, 6]. Beyond clinical consequences, how dentists choose to respond to such incidents, particularly regarding patient disclosure, referral, and documentation, reflects their understanding and implementation of professional ethics.

Adhering to legal and ethical guidelines is vital for sustaining a good and safe patient-dentist relationship. Dentists must be aware of ethical guidelines regarding dental procedures, particularly when errors like instrument fractures occur [3, 7-9].

Prior studies have reported wide variation in disclosure practices. In two separate surveys conducted in Riyadh, 54.5% and 88% of dental practitioners reported an experience of instrument fracture during RCT, while 53.2% and 59.1%, respectively, stated that they had informed the patient about the incident [1, 7]. A study conducted among general dental practitioners in Libya revealed that 90.2% had experienced instrument separation, yet only 4.9% reported attempting retrieval when the fragment was located in the apical region, and nearly half (49.6%) preferred to leave the fragment in place following an unsuccessful removal attempt [10]. Another study focusing on postgraduate trainees indicated that they reported the highest rate of file separation (43.6%) and secondary errors during retrieval (52.1%) [11].

Given the clinical and ethical complexities surrounding endodontic instrument fractures, this study aimed to investigate the ethical perspectives regarding the behavior and attitudes of dentists in Iran. It assessed the perceptions, management, and communication of mishaps by dental professionals, providing insights into existing practices and identifying opportunities for educational improvement to enhance patient care and maintain professional accountability.

Methods

Upon receiving ethical approval from the Ethics Committee

of Zahedan University of Medical Sciences, Zahedan, Iran (IR.ZAUMS.REC.1403.222), 400 questionnaires were disseminated to dentists, including general dental practitioners, endodontists, and various dental specialists operating in clinics throughout multiple cities in Iran. The questionnaire was additionally disseminated online through dental practitioner groups utilizing the Porsline platform. Participants provided written informed consent and were guaranteed confidentiality and voluntary participation.

Data Collection Tool

The questionnaire on the ethical aspects of practitioners' behavior was used based on the Silva questionnaire [3]. The validity and reliability of the standard questionnaire used in the studies by Ba-Hattab et al. and Karunakar et al. had been confirmed [1, 12].

This questionnaire included three sections:

1.Demographic Information

2.Ethical-Behavioral Aspects: This section contained six scenario-based questions. For several questions, respondents were allowed to select more than one option to reflect real-world clinical decision-making (e.g., informing the patient and referring, continuing treatment without informing, etc.).

3.Belief-based Questions: A total of 13 items explored the participants' beliefs and attitudes towards ethical handling of instrument fracture.

The internal consistency of the ethical–behavioral section of the questionnaire was assessed in the current sample using Cronbach's alpha, which yielded a value of 0.77, indicating acceptable reliability.

Data Analysis

Data were analyzed utilizing SPSS (version 24.0) software. Categorical variables were summarized using frequency distributions and percentages. For multiple-response questions, percentages were calculated based on the total number of respondents in each practitioner group, and the sum of responses could exceed the group sample size. An exact test of independence (exact chi-square test) was used for contingency tables with small or zero cell frequencies. This test is conceptually similar to Fisher's exact test and is suitable for tables larger than 2×2. A significance level of $p < 0.05$ was deemed statistically significant.

Results

This study evaluated the ethical perspectives and opinions of 361 dentists regarding the fracture of endodontic instruments. The sample comprised of 169 male (46.8%) and 192 female (53.2%) participants. Based on professional experience, 31.6% had less than five years, 37.7% had 6–10 years, and 30.7% had over 10 years of practice. Regarding qualifications, 90.6% were general dentists, 6.1% were endodontists, and 3.3% specialized in other dental fields. Findings revealed that 85% (N = 307) encountered fractured instrument during root canal preparation. However, the chi-square test indicated no significant difference in frequency across the respondents (P = 0.127). Table 1 shows the frequency distribution of exposure to the phenomenon of instrument fracture during root canal preparation among the respondents.

Table 1- Percentage of respondents who had experienced instrument fracture during RCT

Respondents	Yes N(%)	No N(%)	Total N(%)	P-value
General Dentist	275 (84.1%)	52 (15.9%)	327 (100%)	0.127
Endodontist	22 (100%)	0 (0%)	22 (100%)	
Other Specialists	10 (83.3%)	2 (16.7%)	12 (100%)	

The frequency distribution of dentists' responses to instrument fractures in root canals with a favorable prognosis, categorized by practitioner type, is shown in Table 2. Overall, 191 dentists (52.9%) reported not informing the patient and completing the treatment. The least common response was not informing the patient and referring to a specialist (28 dentists, 7.8%). The Chi-square test showed a significant difference in responses based on practitioner type, with endodontists most frequently not informing the patient and completing the treatment (50%) (P = 0.028).

Table 2- Frequency distribution of dentist's performance when encountering intracanal instrument fracture with good prognosis (Respondents were allowed to select more than one response; therefore, total frequencies may exceed the number of participants in each group.)

Respondents	Inform & Complete Treatment in Another Session N(%)	Inform & Complete Treatment in Same Session N(%)	Inform & Refer to Specialist N(%)	Do Not Inform & Complete Treatment N(%)	Do Not Inform & Refer to Specialist N(%)
General Dentist	64 (17.3%)	66 (17.8%)	36 (10.0%)	178 (48.1%)	26 (7.2%)
Endodontist	4 (18.1%)	7 (31.9%)	0 (0.0%)	11 (50.0%)	0 (0.0%)
Other Specialists	0 (0.0%)	5 (41.7%)	3 (35.7%)	2 (16.6%)	2 (16.6%)

The responses of dentists to instrument fractures in canals with a poor prognosis, categorized by practitioner type, are summarized in Table 3. Most dentists (198; 54.9%) reported informing the patient and referring to a specialist. The least common response was informing the patient and completing the treatment in the same session (48; 6.6%). A

significant difference was found by the practitioner type, with endodontists most often choosing to inform and complete treatment (50%) (P = 0.043).

Table 4 illustrates the therapy of instrument fractures in the coronal section of the root canal according to practitioner type. Most dentists (69.3%) reported removing the instrument, while only 5% chose to leave it in place and follow up. The Chi-square test showed a significant difference by practitioner type, with general dentists performing removal less often than specialists (P = 0.029).

Table 3- Frequency distribution of dentist's performance when encountering intracanal instrument fracture with poor prognosis. (Respondents were allowed to select more than one response; therefore, total frequencies may exceed the number of participants in each group.)

Respondents	Inform & Complete Treatment in Another Session N(%)	Inform & Complete Treatment in Same Session N(%)	Inform & Refer to Specialist N(%)	Do Not Inform & Complete Treatment N(%)	Do Not Inform & Refer to Specialist N(%)
General Dentist	36 (10.2%)	13 (3.8%)	188 (52.9%)	62 (17.4%)	56 (15.7%)
Endodontist	9 (40.9%)	11 (50.0%)	0 (0.0%)	2 (9.1%)	0 (0.0%)
Other Specialists	2 (9.5%)	5 (23.8%)	10 (47.7%)	2 (9.5%)	2 (9.5%)

Table 4- Frequency Distribution of Management of Instrument fracture in the Coronal Part of the Root Canal Based on Type of Practitioner (Respondents were allowed to select more than one response; therefore, total frequencies may exceed the number of participants in each group.)

Respondents	Instrument Removal N (%)	Bypass N (%)	Leaving the Instrument in Place and Following Up N(%)	P-value
General Dentist	220 (58.4%)	137 (36.3%)	18 (4.3%)	0.029
Endodontist	20 (83.3%)	4 (16.7%)	0 (0%)	
Other Specialties	10 (83.3%)	2 (16.7%)	0 (0%)	

The management strategies for instrument fractures occurring in the middle portion of the root canal, classified by practitioner type, are summarized in Table 5. Most dentists (67%) reported bypass, while only 1.7% chose tooth extraction. The Chi-square test showed a significant difference by practitioner type, with general dentists favoring bypass and endodontists recommending removal more often (P = 0.033).

Table 6 shows the management of instrument fracture in the apical part of the root canal by practitioner type. Most dentists (60.7%) reported leaving the instrument in place and following up, while only 3% chose tooth extraction. The Chi-square test showed a statistically significant difference based on practitioner type (P = 0.013).

Table 5- Frequency Distribution of Management of Instrument fracture in the Middle Part of the Root Canal Based on Type of Practitioner (Respondents were allowed to select more than one response; therefore, total frequencies may exceed the number of participants in each group.)

Respondents	Instrument Removal N(%)	Bypass N(%)	Leaving the Instrument in Place and Following Up N(%)	Tooth Extraction N(%)	Referral to Specialist N(%)	P-value
General Dentist	59 (14.9%)	222 (56%)	29 (7.3%)	6 (1.5%)	80 (20.3%)	0.033
Endodontist	9 (64.3%)	5 (35.7%)	0 (0%)	0 (0%)	0 (0%)	
Other Specialties	4 (25%)	5 (31.2%)	0 (0%)	0 (0%)	7 (43.8%)	

Table 6- Frequency Distribution of Management of Instrument fracture in the Apical Part of the Root Canal Based on Type of Practitioner (Respondents were allowed to select more than one response; therefore, total frequencies may exceed the number of participants in each group.)

Respondents	Instrument Removal N(%)	Bypass N(%)	Leaving the Instrument in Place and Following Up N(%)	Tooth Extraction N(%)	Referral to Specialist N(%)	P-value
General Dentist	16 (3.9%)	104 (24.9%)	203 (48.7%)	11 (2.5%)	83 (20%)	0.013
Endodontist	0 (0%)	13 (56.7%)	11 (43.3%)	0 (0%)	0 (0%)	
Other Specialties	0 (0%)	6 (33.3%)	5 (22.9%)	0 (0%)	7 (43.8%)	

Discussion

This study evaluated the ethical considerations and opinions of 361 dental practitioners across Iran about endodontic instrument fracture. With the numerous advancements in the design and metal composition of endodontic instruments, instrument fracture during endodontic procedures continues to pose a significant difficulty [2]. The

question that arises is how clinicians ethically address these challenges. The American Association of Endodontists (AAE) provides a case difficulty assessment form to help predict potential mishaps during RCT and guide effective treatment planning [13].

An essential talent in risk management is the capacity to identify situations that surpass your competence. To make this assessment, you must evaluate potential risks before starting the procedure. If you feel a case is beyond your competence, refer it to a specialist before starting the treatment to reduce the likelihood of malpractice claims [7].

In the analysis of the present study's results, the incidence of instrument fracture during RCT was reported as 85% (307 practitioners reported experiencing instrument fracture). It was found that 100% of endodontists had experienced it. This is while a study in Pakistan had mentioned this rate as 69.1%, and the highest rate was among post-graduate students [11]. Other studies in Brazil and Riyadh, Saudi Arabia, also reported failure rates of endodontic instruments of 56 and 88 percent, respectively, with the highest rates in both studies occurring among endodontic specialists [3, 7]. The present study reported a higher rate of instrument fracture (85%) than the other studies. This difference could be due to different sample composition, years of experience, or questionnaire methods. Cohen et al. (1988) emphasized that instrument fracture during root canal preparation can occur even with the most cautious and skilled dentists, highlighting a common challenge in endodontic treatment [14].

The present study reported a little lower disclosure rate, with only 41.7% of dentists informing patients. Similarly, Hassan et al. found that just 39.6% always disclosed such incidents, while many did so only occasionally or not at all [11]. Silva et al. reported a 53% disclosure rate overall, but only 28.1% among specialists [3]. Mathew et al. showed that 59.1% informed patients, though 22.4% attempted to resolve the issue without informing them [7].

It appears that the decision to inform or withhold information from the patient depends on the dentist's competence and the complexity of the case. WU suggests that if the dentist is capable and confident in retrieving the broken fragment, the patient may not need to be informed, in order to spare them additional stress [15].

The available options for managing cases involving instrument fracture include leaving the fragment, bypassing it, or its removal [1]. The only factor on which the clinicians should base their decision is a careful assessment of the likely prognosis, considering the benefits of instrument removal against the potential risk of complications [16]. The study by Saunders and colleagues (1999) revealed notable differences between general dental practitioners and specialists in managing fractured instruments. Management approaches varied depending on the location of the fracture: 58.4% of general dentists opted to remove fragments in the coronal third, while this rate dropped to 14.9% and 3.9% for fractures in the middle and apical thirds, respectively. For apical third fractures, 48.7% of general dentists chose to leave the fragment in place and monitor the patient, whereas 24.9% attempted to bypass it. Approximately 20% of general dentists referred cases involving middle or apical third fractures to specialists, reflecting a relatively low referral rate. Saunders et al. noted that referral decisions are influenced by factors such as root perforation, the need for retreatment, or surgical intervention [17].

In both the present study and the study by Hassan et al., the predominant approach to managing instrument fracture in root canals with a favorable prognosis was to complete the treatment without removing the fragment. However, a notable difference lies in patient disclosure: while 52.9% of practitioners in the current study proceeded without informing the patient, Hassan et al. reported that 43.6% continued treatment without instrument retrieval, without a statistically significant emphasis on disclosure. Moreover, Hassan et al. found that 38.9% attempted bypassing the fragment, and only 4% opted for removal. These findings highlight a greater tendency toward non-disclosure in the current study, despite similar overall management strategies [11].

Both the present study and the study by Hassan et al. emphasize the importance of proper management in cases of instrument fracture, particularly in teeth with poor prognosis or symptoms. In such cases, there was a higher likelihood of informing patients and referring to specialists, with 54.9% of practitioners in the current study doing so compared to only 19.5% in Hassan et al., who reported that 47.7% attempted to bypass the fractured instrument [11].

This study did not include any questions regarding root curvature, the type and length of fractured instruments, or other factors that might influence the clinician's decision-making. Nevertheless, the practitioner's experience appeared to play a significant role in determining the management of fractured instruments at different root areas. This report recommends three principal approaches to tackle the identified ethical challenges: (1) Integrate targeted ethics training into dental education, specifically regarding error disclosure and patient communication; (2) Develop national protocols for the disclosure of incidents such as instrument fractures to ensure uniformity; and (3) Mandate the documentation of clinical errors in patient records to enhance accountability and trust. These measures can enhance the ethicality and transparency of dental practices. Future research should be conducted prospectively to assess the reporting and management of endodontic tool fractures and to establish suitable protocols.

Conclusion

The findings of this survey-based study indicated that over

two-thirds of dentists had encountered the fracture of endodontic instruments, and the majority had remained reluctant to disclose the incidence to patients and failed to manage it appropriately. Endodontic experts exhibited superior performance compared to other practitioners in specific instances.

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Using AI: AI tools were used only for language editing. The authors reviewed and approved the final manuscript.

Conflict of Interest: " The authors declare that there is no conflict of interest regarding the publication of this article."

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