Survey of challenges and mistakes in root canal preparation: A study from Bulgaria

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Abstract:

Aim: The aim of this study is to investigate the challenges and procedural errors encountered by dentists in Bulgaria during root canal preparation.

Materials and methods: An original questionnaire consisting of five questions was developed and distributed at congresses, seminars, and through Microsoft Forms to dentists in Bulgaria regarding their challenges and procedural errors encountered during root canal preparation.

Results: The survey of 213 Bulgarian dentists found that most handle fewer than five primary endodontic cases per week. Common complications include instrument separation (24.9%) and dentinal mud accumulation (24.4%). Trends showed more dentinal mud accumulation with Blue alloys (68.8%) and more ledge formation with Gold alloys (31.4%).

Conclusion: This survey among Bulgarian dentists identified key challenges in root canal preparation with common complications including instrument separation, dentinal mud accumulation, and ledge formation. These findings emphasize the importance of best practices to minimize errors and improve treatment outcomes.

Key words: procedural error, ledge, instrument separation, root canal transportation, dentinal mud, questionnaire

Introduction:

Endodontic therapy is a multifaceted procedure aimed at removing necrotic tissues, bacteria, and infected dentin to prevent or resolve apical periodontitis [1]. However, the intricate anatomy of the root canal system makes achieving this goal challenging. Therefore, a comprehensive understanding of the variations in root canal structure is critical for effective treatment, particularly in cleaning and shaping the canals. Over the past few decades, significant advancements in instrumentation, techniques, and overall procedures have enhanced the quality of endodontic care. Nevertheless, procedural mistakes such as ledge formation, apical canal transportation, and instrument breakage still persist if proper protocols are not followed [2]. Some studies have documented frequent errors in endodontic procedures [3-4]. These complications have various complex origins, often linked to each phase of the treatment process. They can stem from diagnostic inaccuracies, challenging root canal anatomy, failure to follow aseptic protocols, improper shaping, and factors related to the patient or practitioner. It is essential for clinicians to understand that any error during root canal therapy can negatively influence the prognosis and lead to treatment failure. Knowledge of common procedural mistakes, especially during root canal shaping, and their potential consequences is crucial for preventing such issues and achieving successful outcomes. Adhering to both mechanical and biological guidelines during canal shaping and cleaning helps minimize unnecessary complications. Thus the aim of this study is to investigate the challenges and procedural errors encountered by dentists in Bulgaria during root canal preparation.

Material and method:

An individual survey was conducted using a questionnaire specifically developed for this study. The questionnaire consisted of five questions addressing the frequency of patients requiring root canal treatment, the challenges encountered during root canal shaping, and the instrument systems commonly used.

The questionnaires were distributed during congresses and seminars organized by the Bulgarian Dental Association. Additionally, they were sent via email to all dentists registered with the Bulgarian Dental Association through the Microsoft Forms platform. For statistical analysis, the Chi-square test and Fisher's exact test were employed.

Results:

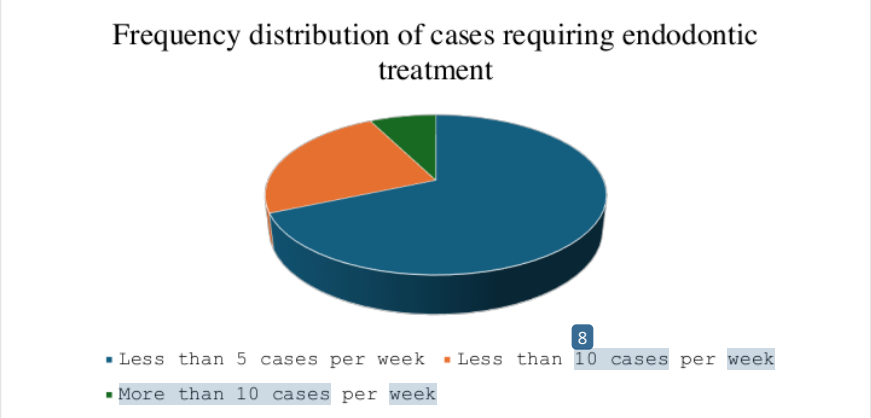
This section presents the findings of a survey conducted among dental practitioners in the Republic of Bulgaria. The survey aimed to assess the challenges and difficulties encountered by practitioners during root canal preparation. The data were analyzed using IBM SPSS Statistics for Windows, Version 27.0 (2020, Armonk, NY: IBM Corp).

The survey responses are presented as numbers and percentages (%). The Chi-square test was applied to identify relationships between specific responses, while Fisher's exact test was used to compare proportions. All statistical analyses were performed with a Type I error rate (alpha) set at 5% ($p < 0.05$). Statistical significance is reported using the following thresholds: * for $p < 0.05$, ** for $p < 0.01$, and *** for $p < 0.001$.

The survey was conducted from March 14, 2022, to May 18, 2022, with a total of 213 dentists participating.

Frequency of cases requiring primary endodontic treatment

Regarding the frequency of cases requiring primary endodontic treatment, the response "less than 5 cases per week" is significantly predominant, reported by 146 (68.5%) dentists ($p < 0.001$). The next most common response is "less than 10 cases per week," selected by 51 (24.0%) dentists, while the least common response is "more than 10 cases per week," reported by 16 (7.5%) participants (**Figure 1**).



*** - Significantly higher relative proportion ($p > 0.001$)

Figure 1: Frequency distribution of cases requiring endodontic treatment

Common complications during root canal preparation in the practice of surveyed dentists

Regarding the most common complications during root canal preparation, 140 (65.8%) dentists reported one complication, while 73 (34.2%) reported more than one complication (**Table 1**).

Table 1: Complications during root canal shaping

Complication identified as the most frequent by participants	**Number of respondents**	**%**
1. Instrument Separation	53	24.90%
2. Dentinal mud accumulation	52	24.40%
3. Ledge	21	10.00%
4. Root canal transportation	13	6.00%
5. Strip perforation	1	0.50%
Total	**140**	**65.80%**
The most frequent combination of complications identified by participants		
1. Dentinal mud accumulation, Ledge	32	15.00%
2. Dentinal mud accumulation, Instrument separation	12	5.50%
3. Dentinal mud accumulation, Root canal transportation	7	3.20%
4. Dentinal mud accumulation, Strip perforation	1	0.50%
5. Dentinal mud accumulation, Ledge, Instrument separation	1	0.50%
6. Dentinal mud accumulation, Root canal transportation, Instrument separation	1	0.50%
Total	**54**	**25.20%**
7. Ledge, Instrument separation	13	6.00%
8. Ledge, Root canal transportation	5	2.50%
9. Ledge, Strip perforation	1	0.50%
Total	**19**	**9.00%**
Total	**73**	**34.20%**

Among single responses, instrument "Separation" was the most common complication, reported by 53 (24.9%) respondents. "Dentinal mud accumulation" followed closely as the next most common complication, noted in 52 (24.4%) responses. "Ledge" accounted for 10% (n = 21) of the reported complications. "Root canal transportation" was mentioned by 6% (n = 13) of the dentists. "Strip perforation" of the root canal was cited in only one response (0.5%).

In combined responses, "dentinal mud accumulation" occurred 54 times (25.2%) in combination with other complications, with the most frequent combinations being "Dentinal mud accumulation" and "Ledge"(15%), "Dentinal mud accumulation" and "Separation" (5.6%), and "Dentinal mud accumulation" and "Root canal transportation" (3.5%). "Ledge" appeared in combination with other complications in 19 (9%) responses, most commonly with "Separation" (6%, n = 13). "Ledge" and "Root canal transportation" occurred in 2.5% (n = 5)

of responses, while “Ledge” and “Strip perforation” were mentioned in only one response (0.5%).

The total number of each type of complication, whether reported singly or in combination with others, is presented in **Figure 2**. “Dentinal mud accumulation” emerged as the most common complication in the practice of the surveyed dentists, occurring in 106 completed questionnaires. The next most common complication was “Separation”, which appeared in the responses of 80 participants. “Ledge” was mentioned with similar frequency in 73 questionnaires. The remaining two types of complications were rare: “Root canal transportation” was reported by 26 dentists, and “Strip perforation” of the root canal was mentioned by only three participants.

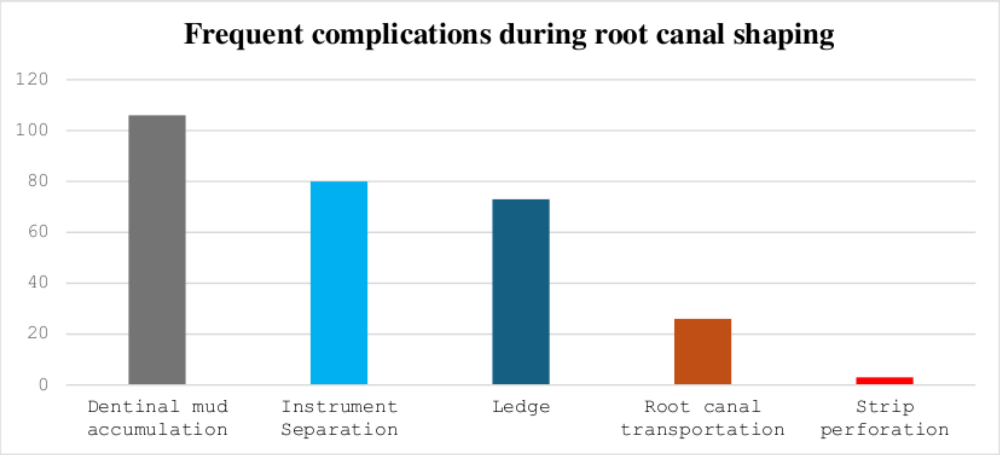


Figure 2: Frequent complications during root canal shaping

Analysis of the relationship between frequent complications and the used machine-driven systems

Overall, no significant association was found between the machine-driven systems used and the type of frequent complications reported by dentists ($p = 0.691$). However, some trends were observed: a higher relative proportion of “Dentinal mud accumulation” (68.8%) was noted in the "Blue alloys" group compared to the other systems, while a higher percentage of “Ledge”complications (31.4%) was seen with "Gold alloys." Additionally, "Gold alloys" had the lowest rate of “Separation” (14%) compared to the other systems.

Analysis of the relationship between frequent complications and the practice of combining or not combining instruments from different systems during root canal treatment

The relationship between the most frequently occurring complications and whether dentists combine instruments from different systems was analyzed using the Chi-square test. The results revealed a similar distribution of complication types among dentists who combine instruments and those who do not, with no significant difference between the two groups ($p = 0.691$).

The relationship between the occurrence of one or more complications and the practice of combining or not combining instruments from different systems was also examined. Again, no significant association was found between these two factors ($p = 0.103$). Among dentists who combined instruments from different systems, 60% reported one type of common complication, while 40% reported more than one complication. In contrast, among those who did not combine instruments, 70% reported one complication, and 30% reported more than one.

Discussion:

This survey was conducted to evaluate the challenges and procedural errors encountered by dentists in Bulgaria during root canal treatments.

In our survey, when asked about the most common complications encountered during root canal treatment, 65.8% of clinicians reported only one complication, while 34.2% mentioned several. Among the single responses, instrument separation was the most common, accounting for 24.9% of all answers. The complication referred to as 'threshold' was reported by 10% of participants. Azeez et al. (5) reported similar findings, dividing complications into those occurring during manual and machine processing. In their study, the most common complication in manual processing was 'threshold,' which was reported by 49.5% of respondents. This can be attributed to the rigidity of manual instruments. In terms of machine processing, both studies found that 'instrument separation' was the predominant complication, while other issues occurred less frequently.

Ahmed et al. (6) identified the most common protocol errors in their survey as instrument separation and perforation. Instrument separation is often associated with improper technique and a lack of adherence to basic safety requirements. Understanding the causes of instrument separation—such as cyclic and torsional fatigue—along with knowledge of the metallurgical properties of NiTi alloy, can significantly reduce the frequency of procedural error.

Conclusion:

The survey conducted among dentists in Bulgaria reveals significant insights into the challenges faced during root canal preparation. The data indicate that the majority of clinicians encounter fewer than five primary endodontic cases per week, with common complications including instrument separation, dentinal mud accumulation, and ledge formation. The analysis did not find a significant correlation between the type of machine-driven system used and the frequency of complications. Additionally, combining instruments from different systems did not show a notable impact on complication rates. These findings highlight the importance of adhering to best practices to minimize procedural errors and ensure better outcomes in endodontic treatments.

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