

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

2 **Abstract:**

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

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

9 **Results:** The survey of 213 Bulgarian dentists found that most handle fewer than five
10 primary endodontic cases per week. Common complications include instrument separation
11 (24.9%) and dentinal mud accumulation (24.4%). Trends showed more dentinal mud
12 accumulation with Blue alloys (68.8%) and more ledge formation with Gold alloys (31.4%).

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

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

19

20 **Introduction:**

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

41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73

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:

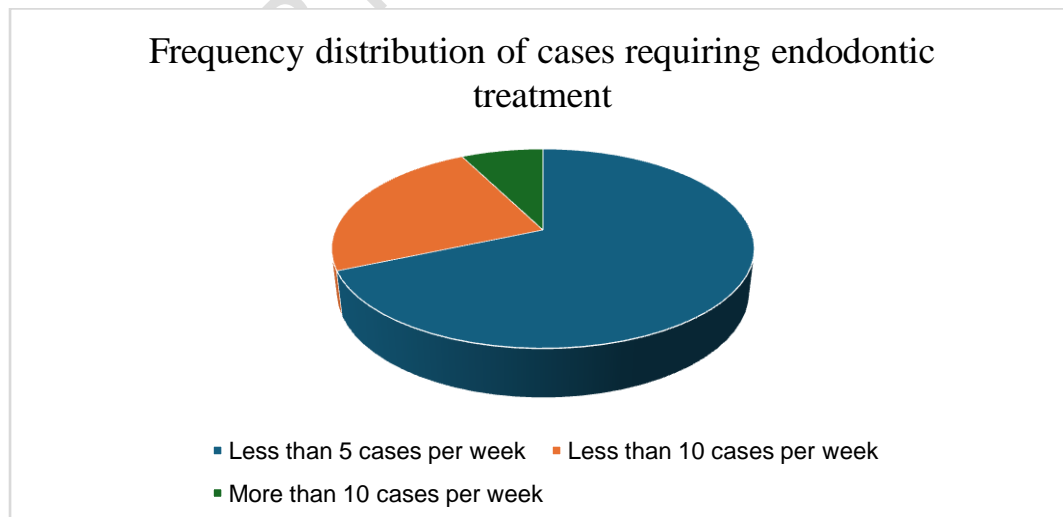
This section presents the findings of a survey conducted among dental practitioners in the Republic of Bulgaria. The survey aimed to assess the challenges and difficulties encountered by practitioners during root canal preparation. The data were analyzed using IBM SPSS Statistics for Windows, Version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

74
75
76
77

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

81 Regarding the most common complications during root canal preparation, 140
82 (65.8%) dentists reported one complication, while 73 (34.2%) reported more than one
83 complication (**Table 1**).

84 *Table 1: Complications during root canal shaping*

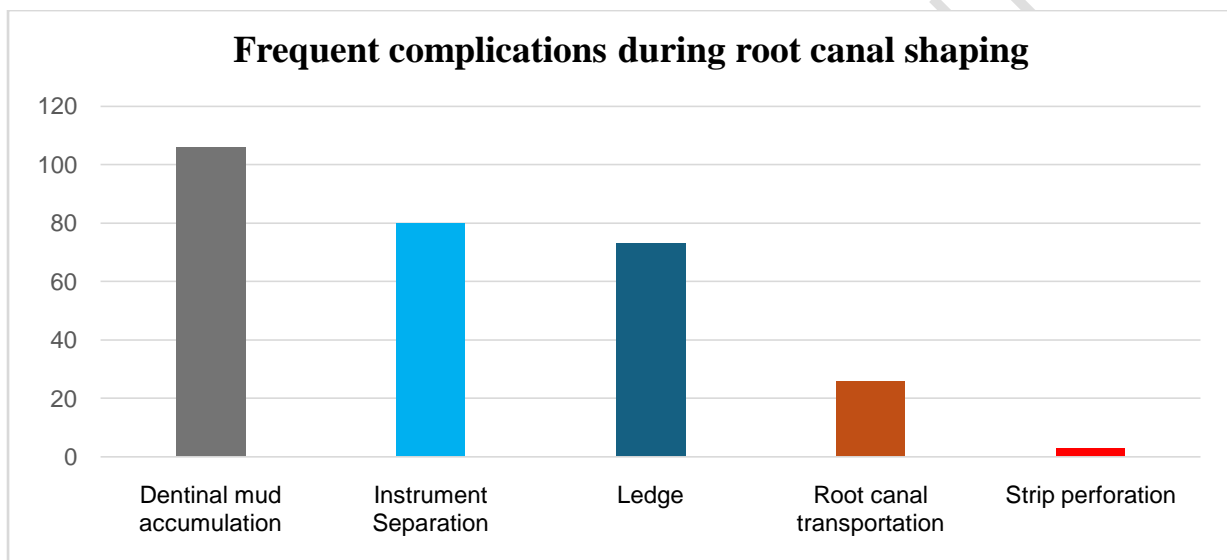
Complication identified as the most frequent by participants	Number of respondents	%
1. Instrument Separation	53	24.90%
2. Dentinal mud accumulation	52	24.40%
3. Ledge	21	10.00%
4. Root canal transportation	13	6.00%
5. Strip perforation	1	0.50%
Total	140	65.80%
The most frequent combination of complications 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%
	54	25.20%
Total		
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%

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

91 In combined responses, “dentinal mud accumulation” occurred 54 times (25.2%) in
92 combination with other complications, with the most frequent combinations being “Dentinal
93 mud accumulation” and “Ledge”(15%), “Dentinal mud accumulation” and “Separation”

94 (5.6%), and “Dentinal mud accumulation” and “Root canal transportation” (3.5%). “Ledge”
95 appeared in combination with other complications in 19 (9%) responses, most commonly
96 with “Separation” (6%, n = 13). “Ledge” and “Root canal transportation” occurred in 2.5% (n
97 = 5) of responses, while “Ledge” and “Strip perforation” were mentioned in only one
98 response (0.5%).

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



107

108 **Figure 2: Frequent complications during root canal shaping**

109 **Analysis of the relationship between frequent complications and the used machine-** 110 **driven systems**

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

117 **Analysis of the relationship between frequent complications and the practice of** 118 **combining or not combining instruments from different systems during root canal** 119 **treatment**

120 The relationship between the most frequently occurring complications and whether
121 dentists combine instruments from different systems was analyzed using the Chi-square test.
122 The results revealed a similar distribution of complication types among dentists who combine

123 instruments and those who do not, with no significant difference between the two groups ($p =$
124 0.691).

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

132 **Discussion:**

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

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

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

152 **Conclusion:**

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

163 **References:**

- 164 1. Tamilselvi R, Kumari VA, Porkodi I. Factors Influencing Ledge Formation and Its
165 Management in Endodontics. *Indian Journal of Forensic Medicine & Toxicology*. 2020 Oct
166 29;14(4):1193-7.
- 167 2. Nagy CD, Bartha K, Bernath M, Verdes E, Szabo J. The effect of root canal morphology
168 on canal shape following instrumentation using different techniques. *International*
169 *Endodontic Journal*. 1997 Mar;30(2):133-40.

- 171
172 3. Peters OA. Current challenges and concepts in the preparation of root canal systems: a
173 review. *Journal of endodontics*. 2004 Aug 1;30(8):559-67.
174
175 4. Kapalas A, Lambrianidis T. Factors associated with root canal ledging during
176 instrumentation. *Dental Traumatology*. 2000 Oct;16(5):229-31.
177
178 5. Azeez S. Choice of rotary instrument usage among endodontists and general
179 practitioners—A questionnaire survey. *Medical Journal of Babylon*. 2021;18(4):428.
180
181 6. Osman Ahmed MA, Awooda EM. A Survey of Usage Parameters of Nickel-Titanium
182 Rotary Files Among Dentists Working Within Private Clinics in the City of Khartoum, Sudan.
183 *Saudi Journal of Oral and Dental Research*. 2020 Sep 19;5(9):485–8.
184
185
186

UNDER PEER REVIEW IN IJAJ