

1 Survey of the usage of endodontic instruments

2 Abstract:

3 **Aim:** The aim of this study is to explore the opinions and practices of dentists in Bulgaria
4 regarding the use of machine-driven instruments in root canal treatment.

5 **Materials and methods:** An original questionnaire consisting of 10 questions was developed
6 and distributed at congresses, seminars, and through Microsoft Forms to dentists in Bulgaria
7 regarding their knowledge and use of Ni-Ti machine-driven instruments.

8 **Results:** A survey was conducted among 213 dentists, comprising both socio-demographic
9 and clinical practice-focused questions. Most participants were between 25 and 45 years old,
10 with 58.6% being female. While 69.5% of clinicians adopted a hybrid approach combining
11 manual and power-driven instruments for glide path creation, 48.4% used fully machine-
12 driven instruments for root canal negotiation. The "Gold alloys" system emerged as the most
13 commonly used, both individually and in combination, while newer-generation systems with
14 advanced metallurgical properties were less frequently utilized.

15 **Conclusion:** Despite the recognized advantages of machine-driven instruments, clinicians
16 predominantly relied on older technologies, highlighting gaps in familiarity with modern
17 innovations. The findings underscore the need for further education and training to enhance
18 the adoption of advanced systems, which offer improved efficiency and outcomes in
19 endodontic practice.

20 **Key words:** endodontic instruments, machine-driven instruments, mechanical shaping,
21 nickel-titanium

22 Introduction:

23 The evolution of machine-driven instrument systems represents a significant
24 advancement in root canal preparation (1). These systems are designed to optimize the
25 process, enabling practitioners to navigate the complexities of varied root canal anatomies
26 with greater precision and efficiency. By employing such tools, clinicians can create a space
27 within the root canal that is both effectively disinfected and sealed in a predictable, three-
28 dimensional manner, enhancing treatment outcomes. Among these systems, nickel-titanium
29 (NiTi) instruments have become particularly popular due to their flexibility and ability to
30 adapt to intricate canal curvatures. Despite their advantages, the widespread adoption of NiTi
31 instruments remains limited. Many clinicians are hesitant to fully embrace their use, largely
32 due to concerns about the risk of instrument separation during the critical stages of root canal
33 preparation (1). This hesitation underscores the need for ongoing education and innovation in
34 the development and safe application of these advanced tools, thus the aim of this study is to
35 explore the opinions and practices of dentists in Bulgaria regarding the use of machine-driven
36 instruments in root canal treatment.

37 Material and method:

38 An individual survey was conducted using a questionnaire specifically designed for the
39 study. The questionnaire was divided into two sections:

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- 41 • Two questions focused on the socio-demographic characteristics of the participants.

- Eight questions addressed the observed variables under investigation.

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 results of a survey conducted among dental practitioners in the Republic of Bulgaria. The survey aimed to examine the challenges and issues they face when using machine-driven NiTi instruments for root canal treatments. 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 $p < 0.001$.

Demographic data of the survey participants

The survey was conducted from March 14, 2022, to May 18, 2022, with a total of 213 dentists participating. Among them, 125 (58.60%) were women, and 88 (41.40%) were men (Figure 1).

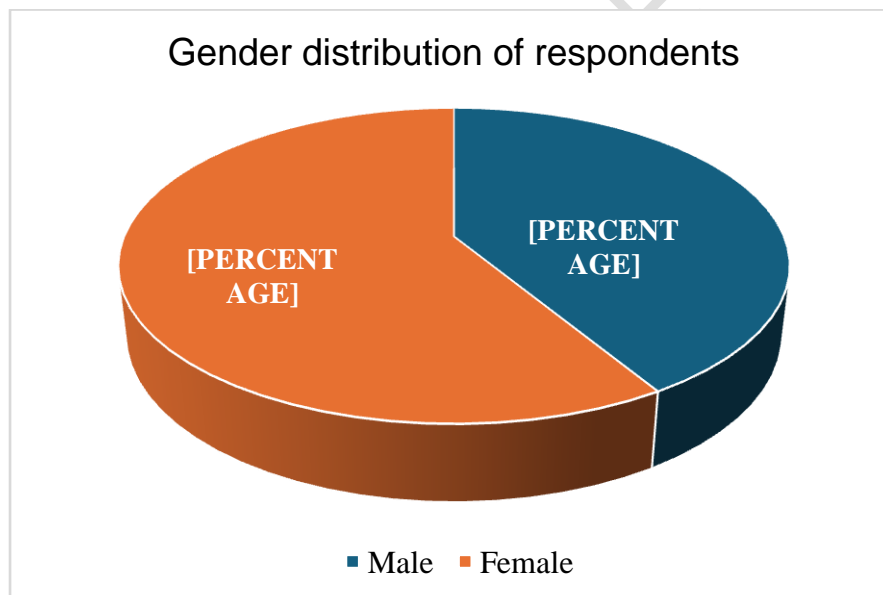


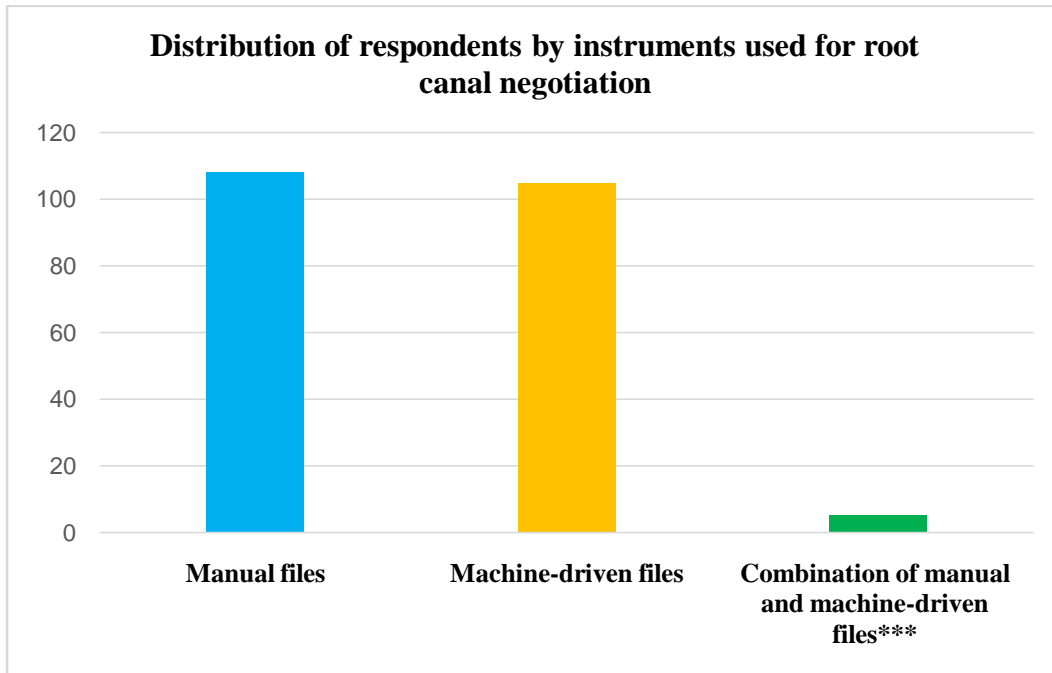
Figure 1: Gender distribution of respondents

The age distribution of respondents was as follows:

- 92 (43.20%) were in the 25–30 age group.
- 91 (42.70%) were in the 31–45 age group.
- 20 (9.40%) were in the 46–55 age group.
- 10 (4.70%) were over 55 years old.

Root Canal Treatment with Machine-Driven NiTi Instruments Among Surveyed Dentists

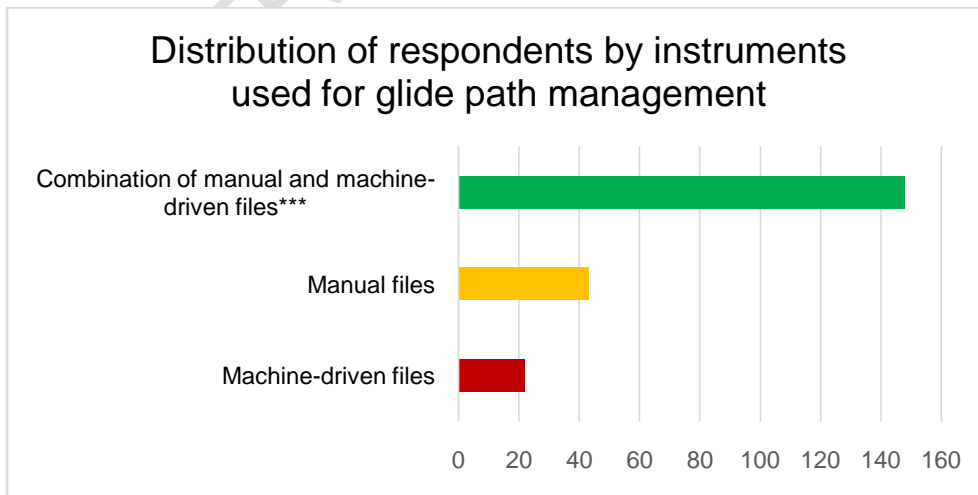
77 In root canal negotiation, 108 dentists (49.30%) used fully manual instruments, 105
 78 (48.40%) used fully machine-driven instruments (“Manual-less”), and 5 (2.30%) employed a
 79 combination of manual and machine-driven instruments (**Figure 2**). The proportion of
 80 dentists using a hybrid method was significantly lower than those using either fully manual or
 81 fully machine-driven instruments ($p < 0.001$).
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 84 *** - Significantly lower relative proportion ($p > 0.001$)

85 **Figure 2:** Distribution of respondents by instruments used for root canal negotiation

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 87 For glide path management, 43 dentists (20.20%) relied on fully manual instruments,
 88 and 22 (10.30%) used fully machine-driven instruments. However, the majority—148
 89 dentists (69.50%) — combined manual and machine-driven instruments for this purpose.
 90 This hybrid approach was significantly more common than the exclusive use of manual or
 91 machine-driven instruments ($p < 0.001$, **Figure 3**).
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 94 *** - Significantly higher relative proportion ($p > 0.001$)

95 **Figure 3:** Distribution of respondents by instruments used for glide path management

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Preferred Machine-Driven Systems

The survey also asked dentists to identify the machine-driven systems they used for root canal treatment, allowing them to select more than one option from seven pre-defined systems or to add another under the “Other” category. The results are summarized in **Table 1**:

Table 1: Machine-Driven Systems for Root Canal Treatment:

Machine-driven system	Percentage (%)
Protaper Gold / WaveOne Gold / COXO SC Pro / VS Flexi (“Gold”)	18%
Protaper NEXT / WaveOne (M-Wire)	15.50%
ProTaper Universal	9%
Vortex Blue/Reciproc Blue / VS Flexi VT Blue / Race Evo (“Blue”)	6.5%
XP-endo (MaxWire)	2%
TruNatomy (SuperFlex)	1.70%
Protaper Ultimate (M-Wire / Gold / Blue)	0.50%
Other	8%

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In total, 82 respondents (38.50%) selected more than one system, with combinations varying widely and not falling into specific categories.

During root canal treatment, 90 dentists (42.30%) combined instruments from different machine-driven systems, while the remaining 123 (57.70%) did not. The frequency of individual systems used in combination with others is summarized in **Table 2**:

Table 2: Frequency of individual systems used in combination with others

Machine-driven system	Used in combination by dentists
Protaper Gold / WaveOne Gold / COXO SC Pro / VS Flexi (“Gold”)	51
Protaper NEXT / WaveOne (M-Wire)	46
ProTaper Universal	36
Protaper Ultimate (M-Wire / Gold / Blue)	28
TruNatomy (SuperFlex)	12
Vortex Blue/Reciproc Blue / VS Flexi VT Blue / Race Evo (“Blue”)	6
XP-endo (MaxWire)	3

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Overall Usage

In total, 89 dentists used the Protaper Gold / WaveOne Gold / COXO SC Pro / VS Flexi (“Gold”) system, making it the most frequently used system, either alone or in combination. Protaper NEXT / WaveOne (M-Wire) followed with 80 users, and Protaper Universal was used by 55 respondents. These three systems emerged as the most commonly used, either individually or in combination. Other systems were used less frequently (**Figure 4**):

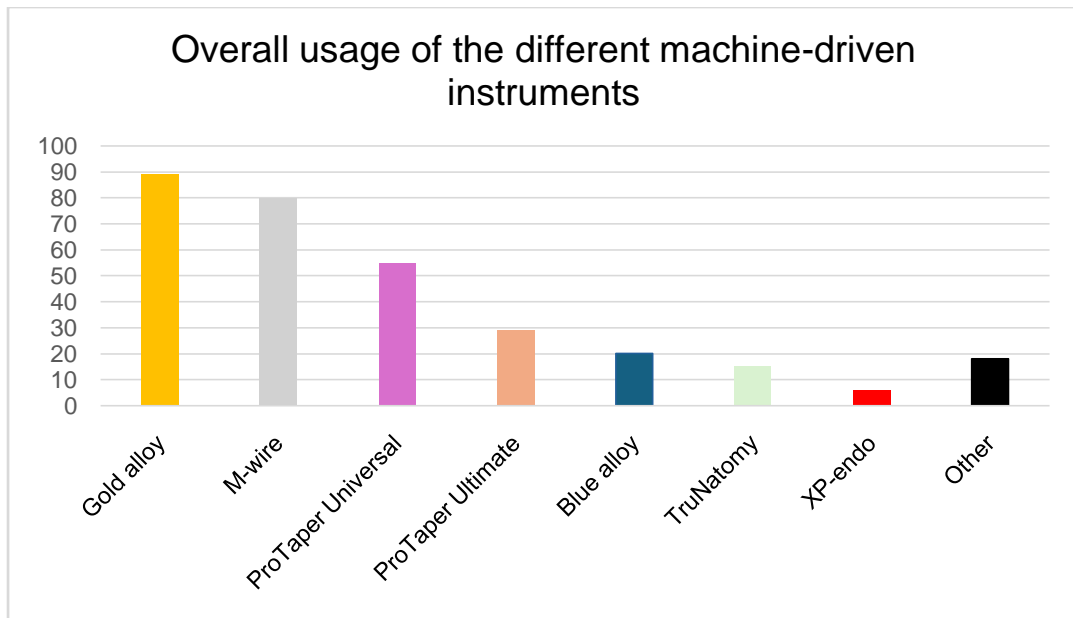


Figure 4: Overall usage of the different machine-driven instruments

Discussion:

This survey was conducted to investigate the opinions of clinicians in Bulgaria regarding the use of machine-driven instruments. The majority of participating clinicians were between 25 and 45 years old. This finding aligns with a study by Azeez et al., which reported that the average age of clinicians participating in their survey was 32 years [1]. Conversely, Patturaja et al. reported that 30% of the participants in their study had over 20 years of clinical experience [2].

In the current survey, one question focused on the shaping systems used by clinicians. The most frequently reported system was categorized under "Gold alloys." A correlation was observed between the age of the participants and their interest in modern instrumentation technologies. Younger clinicians were more familiar with these technologies and appreciated their ability to follow root canal anatomy in detail without causing disruptions. In contrast, Azeez et al. found that a large proportion of clinicians still relied on manual instruments for canal preparation [1]. Similarly, in a survey by Patturaja et al., 40% of clinicians preferred working with the Mtwo system [2]. Another study by Patil et al. reported that 86.2% of clinicians preferred the ProTaper Universal system, highlighting that clinicians in developing countries tend to rely on well-established systems and are slower to adopt new technologies [3].

Patturaja et al. also examined the use of power-driven instruments and clinician preferences for specific systems [2]. Regarding the choice between fully manual, fully power-driven, or hybrid techniques, their results were similar to ours. In our survey, the majority of clinicians (56%) reported using a combination of manual and power-driven instruments during root canal treatment. Similarly, Azeez et al. noted that 37.8% of clinicians processed root canals fully manually, 22.5% relied entirely on power-driven instruments, and 39.6% combined manual and power-driven systems [1]. By comparison, in our survey, 69.5% of Bulgarian clinicians reported using a hybrid technique to create a glide path as part of mechanical root canal preparation.

A survey by Patil et al. focused on the use of different NiTi systems for root canal treatment and their frequency of use [3]. On the topic of glide path creation, their results partially differed from ours. Most clinicians in their survey (56.4%) reported creating a glide path entirely manually, 29.5% reported doing so entirely mechanically, and 14.1% indicated

155 their approach depended on the case. In contrast, in our survey, 69.5% of clinicians used a
156 combination of hand and power-driven systems, while 10.3% created the glide path entirely
157 mechanically and 20.2% entirely manually.

158 When asked about combining instruments from different power-driven systems,
159 42.3% of our participants stated that they did so, while 57.7% did not. By comparison, Patil
160 et al. found that only 36% of their participants combined instruments [3]. Additionally,
161 Logsdon et al. reported that 98.3% of their study participants used NiTi instruments for root
162 canal treatment [4]. They also observed a statistically significant correlation between more
163 years of clinical experience and the use of machine-driven NiTi instruments.

164 Ahmed et al. conducted a survey among clinicians in private practice regarding the
165 use of NiTi rotary instruments [5]. Their findings revealed that NiTi rotary instruments were
166 most frequently used by clinicians with 5–10 years of experience. Among the instrument
167 systems, ProTaper was the most frequently used, while ProTaper Gold was the least
168 frequently used. Similarly, Cheung et al. reported that 97.6% of clinicians surveyed used
169 machine-driven NiTi instruments in their practice, although only 60% used more modern
170 systems featuring heat-treated alloys [6].

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172 **Conclusion:**

173 Dentists in Bulgaria are not yet fully familiar with the latest machine-driven
174 instrument systems and do not fully appreciate their advantages. They primarily rely on
175 "gold" alloys and "M-wire" technology, which have been superseded by newer generations of
176 NiTi alloys with more advanced physical properties. Despite this, a significant proportion of
177 dentists recognize the benefits of using fully machine-driven instruments for root canal
178 negotiation, indicating an interest in adopting innovations in endodontic practice. However,
179 the majority of dentists rely on a single machine-driven instrument system during root canal
180 treatment. This highlights the need for greater awareness of newer-generation systems, which
181 integrate various metallurgical characteristics to optimize endodontic treatment without
182 requiring the use of multiple instrument systems.

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