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Determination of materials, techniques, and application methods preferred by Turkish dentists in endodontic treatment

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Purpose: This study aimed to examine the materials, methods, and application techniques used by general dentists in root canal treatment through a survey and to compare the findings with previous studies conducted in Turkey and globally.

Methods: A survey consisting of 21 questions was administered to 691 general dentists working in private clinics and public institutions in İzmir. Participation was voluntary, and data were analyzed using the Chi-Square test with IBM SPSS Statistics 23 software.

Results: Among the participants, 22.7% did not perform root canal treatment. The electric pulp test was the most preferred vitality test (47%), while electronic apex locators were widely used for determining the working length. Sodium hypochlorite (91.6%) was the most common irrigation solution, and calcium hydroxide (91.4%) was the preferred intracanal medication. Nickel-titanium rotary files were used by 85.6% of dentists, and 72.1% employed the single-cone technique for root canal filling. Notably, only 1.5% used a rubber dam.

Conclusion: Older dentists tended to favor conventional methods, while no standardization was observed in material and method selection across demographic groups. The use of rubber dams was significantly lower than international standards.

Keywords: Endodontic treatment; root canal treatment; survey.

Introduction

The primary goal in dentistry is to maintain the functions of teeth while ensuring their long-term health in the oral cavity. Tooth loss not only leads to aesthetic and functional deficits but also causes various complications, including malposition of adjacent teeth, occlusal problems, periodontal issues, increased risk of caries, and chewing difficulties (1). One of the most effective methods to prevent these adverse effects and preserve the tooth in the oral cavity is root canal treatment.

Root canal treatment is a complex procedure that involves the removal of infected or necrotic pulp tissue, mechanical and chemical cleaning of the root canals, disinfection, and hermetic sealing of the canals. The success of this treatment depends not only on biological and mechanical principles but also on the effectiveness of the materials and techniques used by dentists (2).

Endodontics is a dynamic field of dentistry where new knowledge and technologies are developed within short time intervals. With advancing technology, the production

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of new materials and the continuous evaluation of their effectiveness are essential aspects of scientific progress. The success of endodontic treatment depends not only on the clinician's skills but also on their access to up-to-date information and innovations (3).

The success of endodontic treatment relies on the accurate and effective execution of multiple interdependent steps. Key factors include establishing a correct diagnosis, preventing complications during access cavity preparation, accurately determining the working length, ensuring proper isolation, effectively shaping the root canals (4), performing irrigation with appropriate solutions and activation techniques (5), and achieving a hermetic seal during canal obturation. The selection and proper application of different techniques and materials for each step play a crucial role in determining the overall success of the treatment (6).

The aim of this study is to identify the materials, techniques, and application methods preferred by general dentists in root canal treatment and to compare these findings with current literature. Through this comparison, the study aims to enhance the understanding of existing clinical practices and contribute to the development of future educational and clinical strategies.

Materials and Methods

This study was initiated following the approval of the Ethics Committee of Ege University Faculty of Medicine (Decision No: 16-12.1/15). The study was conducted under the principles of the Declaration of Helsinki. To collect data, a questionnaire consisting of 21 questions was designed. The first section of the questionnaire included four questions to gather demographic information about the participants (gender, age, years of clinical experience, and workplace). The second section comprised 17 multiple-choice questions aimed at evaluating the materials, techniques, and applications used in root canal treatment.

The study focused on general dentists. A total of 691 general dentists working in private clinics and public institutions in the central and district areas of İzmir voluntarily participated in the study.

The questionnaire was administered face-to-face by a single researcher at the participants' workplaces. The purpose of the study was explained to the participants, voluntary participation was ensured, and the questionnaires were completed independently, without any external influence.

The collected data were analyzed using IBM SPSS Statistics 23 software. The Chi-Square test was used for comparisons between groups, and all hypothesis tests were conducted at a significance level of $p < 0.05$.

Results

The distribution rates of the participants' demographic characteristics are presented in Table 1.

The distribution of dentists' root canal treatment and radiography usage rates based on their workplace, years of experience, and age is presented in Table 2.

Among the surveyed dentists, 22.7% reported that they do not perform root canal treatment. Additionally, it was observed that the rate of performing root canal treatment significantly decreased with increasing age ($p < 0.001$). Furthermore, dentists working in private clinics were found to have a higher rate of performing root canal treatment compared to their colleagues in the public sector ($p < 0.001$).

It was observed that as the dentists' years of experience and age increased, the routine use of radiography during examinations decreased ($p < 0.001$).

The distribution of the survey results of dentists performing root canal treatment based on their workplace, years of experience, and age is presented in Table 3.

No significant difference was observed among participants regarding the use of radiography during endodontic treatment ($p > 0.05$). Similarly, no significant difference was found in the isolation technique used for treated teeth during endodontic procedures ($p > 0.05$).

Among dentists performing root canal treatment, the use of conventional radiography, tactile sensitivity, and paper point methods for determining working length significantly increased with age and years of experience ($p < 0.001$), while the use of electronic apex locators decreased ($p < 0.001$).

Table 1. Demographic characteristics of participants (n = 691)

Variable	n	%
Age		
≤ 35	242	35
36-50	323	46.7
> 50	126	18.2
Gender		
Female	375	54.3
Male	316	45.7
Years of Medical Practice		
≤ 10	232	33.6
11-25	303	43.7
> 26	156	22.5
Institution of Employment		
Public Institution	349	50.5
Private Practice	309	44.7
Public + Private	33	4.8

Table 2. Distribution of root canal treatment and radiography acquisition rates by workplace, average years of practice, and age (%) (n = 691)

Variable	Institution of Employment			Average Years of Practice			Age		
	Public Institution	Private Practice	Public-Private	< 10 Years	11-25 Years	> 26 Years	< 35	36-50	> 51
Root Canal Treatment Frequency									
Always	33.2	79.9*	63.6	57.8	57.8	48.1	56.6	58.8	45.2*
Frequently	20.3	5.8	6.1	12.5	14.9	10.9	12.4	14.6	11.1
Rarely	14.3	2.3	6.1	4.3	8.6	14.7	4.1	10.5	11.9
Never	33.1	12	24.2	25.4	18.8	26.3	26.9	16.1	31.7
Radiography Acquisition Rate									
Yes	86.8	78.6	81.8	90.5	83.2	71.2*	90.9	81.4	71.4*
No	13.2	21.4	18.2	9.5	16.8	28.8	9.1	18.6	28.6*

*The Chi-Square test with a significance level of $p < 0.05$.

No significant difference was observed among participants regarding the instruments used for root canal shaping ($p > 0.05$).

Regarding irrigation solutions, the use of EDTA decreased with age and years of experience ($p = 0.047$), whereas the use of hydrogen peroxide increased ($p = 0.015$).

Among dentists who reported performing root canal treatment, as age and years of experience increased, the use of dental syringes for irrigation solutions also increased ($p < 0.05$), while the use of special irrigation needles decreased ($p < 0.05$). Additionally, dentists working in public institutions were significantly more likely to use dental syringes for irrigation solutions compared to those in private practice ($p = 0.001$), whereas their use of special irrigation needles was significantly lower ($p = 0.004$).

No significant difference was found between the ages and years of experience of dentists performing root canal treatment and the types of root canal sealers they used ($p > 0.05$). However, the use of bioceramic-based sealers was significantly higher among dentists working in private practice compared to those in public institutions ($p = 0.002$).

Additionally, as age and years of experience increased, the preference for the cold lateral compaction technique significantly decreased ($p = 0.004$), while the use of sealer-only obturation significantly increased ($p < 0.001$).

Discussion

In our study, the questionnaires were administered face-to-face to general dentists who voluntarily participated, unlike many other survey-based studies. This approach allowed for a more accurate representation of clinicians' treatment habits by minimizing potential misunderstandings or misinterpretations in responses.

With the evolving societal structure and increasing aesthetic expectations of patients, the demand for preserving natural teeth has made root canal treatment more popular in recent years (7,8). In our study, it was observed that younger dentists preferred performing root canal treatment more frequently compared to their older colleagues ($p < 0.001$). This situation may be attributed to the ability of young dentists to adapt more quickly to changing societal structures and patient expectations, their graduation with an up-to-date curriculum designed following advancing technologies, and their provision of treatment options to patients in line with these developments. Additionally, our study found that root canal treatment was performed at a significantly higher rate in private clinics compared to public institutions ($p < 0.001$). In public institutions, general dentists are typically allocated short appointment slots averaging around 20 minutes per patient through the Central Physician Appointment System (MHRS). The significantly lower rate of root canal treatment among general dentists in public institutions may be due to the lack of sufficient time to complete this multi-step procedure.

Radiographs allow for the examination of radicular and periradicular structures, aiding in the identification of potential causes of patient discomfort (9). In our study, 82.9% of participants reported routinely taking radiographs during examinations. In contrast, a study by Tan et al. (10) reported that 99.7% of dentists routinely used radiographs during examinations. It was also observed that younger dentists were more likely to take routine radiographs compared to their older colleagues ($p < 0.001$). The reasons cited by participants for not taking routine radiographs during examinations included: 27% believed routine radiography was unnecessary, 35% considered that

Table 3. Distribution of outcomes based on the institution, average years of practice, and age of practitioners performing root canal treatment (%) (n = 534)

Variable	Institution of Employment (%)			Years of Medical Practice			Age		
	Public Institution	Private Practice	Public-Private	< 10 Years	11-25 Years	> 26 Years	< 35	36-50	> 51
Radiography Acquisition Stage (Multiple responses were allowed)									
Preoperative	99.6	87.1	96.0	94.2	91.5	94.8	93.8	91.5	96.5
Working Length Determination	36.7	48.5	52.0	36.4	43.1	54.8	37.3	44.3	53.5
Gutta-Percha Trial	50.2	51.5	48.0	60.1	43.9	51.3	59.9	45.4	50.7
Postoperative	95.8	77.6	92.0	85.5	86.2	87.8	84.2	87.1	88.4
Isolation Methods (Multiple responses were allowed)									
Cotton Rolls and Pellets	96.6	86.4	92.0	87.9	94.7	88.7	88.7	94.1	87.2
Suction and Aspirator	92.4	88.2	84.0	87.3	89.8	93.9	87.6	90.4	93.0
Rubber Dam	8.0	23.5	16.0	21.4	13.4	14.8	22.0	12.5	16.3
Working Length Determination Methods (Multiple responses were allowed)									
Conventional Radiographs	14.8	17.6	28.0	12.1	15.9	26.1*	11.9	15.9	30.2*
Digital Radiographs	35.0	45.2	44.0	44.5	39.8	36.5	46.9	37.6	37.2
Electronic Apex Locators	74.7	68.8	64.0	82.7*	69.9	56.5	80.8*	70.5	53.5
Tactile Sensation	30.0	13.2	24.0	17.9	21.5	25.2*	18.6	20.3	29.1*
Paper Point	9.7	9.6	0.0	4.0	10.6	13.9*	4.5	10.7	14.0*
Selection of Endodontic Instruments (Multiple responses were allowed)									
Tirnerf	38.0	43.0	48.0	41.6	38.6	45.2	42.4	36.9	51.2
K-Type File	7.2	12.9	12.0	12.1	10.2	7.8	11.3	10.7	7.0
K-Type Reamer	56.1	57.4	64.0	68.2	47.2	61.7	65.5	50.2	61.6
H-Type File	55.7	52.6	52.0	64.2	49.2	48.7	64.4	49.1	47.7
Gates-Glidden	10.5	18.4	16.0	19.1	13.4	11.3	19.8	12.9	10.5
Peeso Reamer	1.3	2.9	4.0	2.9	2.4	0.9	2.8	2.6	0.0
Ni-Ti Rotary File	87.3	84.2	84.0	90.2	86.6	76.5	90.4	86.7	72.1
Use of Irrigation Solutions (Multiple responses were allowed)									
Sodium Hypochlorite	91.1	91.5	96.0	91.3	92.3	90.4	91.0	93.0	88.4
EDTA or Other Chelating Agents	63.3	72.8	64.0	75.1	64.6	65.2	75.1	65.3	62.8*
Distilled Water	47.3	50.7	48.0	57.8	44.3	46.1	58.8	45.8	39.5
Hydrogen Peroxide	10.1	17.6	8.0	9.8	13.0	21.7	10.2	13.3	23.3*
Chlorhexidine	66.2	58.8	52.0	63.0	58.9	66.1	63.3	59.4	66.3
Irrigation Activation Methods Multiple responses were allowed)									
Syringe Irrigation	82.7	68.8*	84.0	67.0	74.8	82.7*	68.6	72.7	83.6*
Special Irrigation Needles	30.8	45.2*	40.0	48.7*	40.2	29.5	47.7*	42.4	28.2
Sonic-Ultrasonic Irrigation	4.6	9.6	8.0	7.5	7.7	6.1	6.8	8.5	4.7
Negative-Positive Pressure Irrigation (EndoVac etc.)	0.8	1.8	8.0	2.3	1.2	1.7	2.3	1.1	2.3
Irrigation Brushes (EndoBrush etc.)	0.0	0.7	4.0	0.0	0.4	1.7	0.0	0.7	1.2
Ozone Irrigation	0.0	1.8	0.0	0.0	0.8	2.6	0.0	0.7	3.5
Selection of Root Canal Sealers (Multiple responses were allowed)									
Zinc Oxide-Based Sealers	11.8	19.1	24.0	18.5	15.4	13.9	18.1	14.4	17.4
Chloropercha	0.4	2.2	0.0	1.2	0.8	2.6	1.1	0.7	3.5
Calcium Hydroxide-Based Sealers	43.9	38.6	44.0	40.5	38.6	47.8	40.1	38.4	52.3
Glass Ionomer-Based Sealers	3.8	8.5	4.0	6.9	6.1	5.2	6.8	6.7	3.5
Polymer-Based Sealers	54.0	39.3	48.0	45.7	48.0	43.5	45.8	47.6	43.0
Bioceramic-Based Sealers	5.9	15.8*	16.0	10.4	13.0	9.6	10.2	12.9	9.3
Root Canal Filling Techniques (Multiple responses were allowed)									
Single Cone Technique	75.5	68.8	76.0	78.6	68.7	69.6	78.5	69.0	68.6
Cold Lateral Compaction Technique	63.1	59.9	72.0	72.3	56.7	57.4*	71.8	57.4	55.8*
Filling with Sealer Alone	2.1	6.3	4.0	1.7	4.1	8.7	1.7	4.4	9.3*
Intracanal Heating	0.4	2.9	8.0	0.6	1.6	5.2	0.6	2.2	4.7
Extraoral Heating	0.0	2.2	4.0	0.6	1.6	1.7	0.0	1.8	2.3

*The Chi-Square test with a significance level of $p < 0.05$.

indications could be determined through intraoral examination alone, and 25% mentioned that radiographs were not reimbursed during examinations. However, no significant difference was found in the frequency of radiograph use during endodontic procedures between different age groups or work environments ($p > 0.05$).

Although no significant difference was found between the groups in terms of isolation ($p > 0.05$), it was determined that the overall use of rubber dams was quite low across all groups. The main reasons cited by dentists for not using rubber dams included the perception that the application is impractical, time-consuming, and that patients may not tolerate it (11,12). In our study, 45.7% of the participants found rubber dam usage difficult, while 44.1% stated that they could not use it because it was not available in their work environment. However, considering its advantages in infection control, prevention of cross-contamination, and protection of patients from instruments used during the procedure, rubber dam application holds significance beyond these concerns (13). Studies conducted worldwide indicate that the usage rates of rubber dams are higher in developed countries compared to developing ones (14,15).

When evaluating the methods used to determine working length during endodontic treatment, it was observed that as age and years of experience increased, the use of conventional radiography, tactile sensitivity, and paper point methods also increased ($p < 0.001$), whereas the use of electronic apex locators decreased ($p < 0.001$). This decline in the use of electronic apex locators may be attributed to their relatively new and costly technology, the insufficient participation of older dentists in postgraduate education and training courses, or their reluctance to adapt to new technologies. The increased reliance on tactile sensitivity for determining working length with age suggests that dentists may find it difficult to change their established habits. Although experienced clinicians may rely on tactile perception to determine canal length, it should not be overlooked that anatomical obstacles and canal constrictions may cause the instrument to become stuck or lead to apical perforation (16). The literature indicates that electronic apex locators are more successful in determining working length compared to radiographic and tactile sensitivity methods (17,18). Additionally, it has been reported that electronic apex locators eliminate radiation exposure, unlike radiographic methods (19).

From past to present, root canal shaping has been performed using various file materials and systems. With technological advancements, Ni-Ti rotary file systems have gained significant popularity in recent years. In our study, Ni-Ti rotary files were preferred at a higher rate across all age groups and work environments compared to other systems. This trend may be attributed to the increased variety of Ni-Ti rotary instruments, their proven reliability through in-vitro and in-vivo studies, and their ability to reduce complications such as ledge formation, apical transportation, and perforation (20,21). The high usage rate of Ni-Ti file systems in our study is also consistent with findings from other studies in the literature (22,23).

Bacteria play a fundamental role in the development of pulpal and periapical diseases. Therefore, infection control is considered a primary goal of root canal treatment for the prevention and management of endodontic pathologies (24). Irrigation has been adopted as the primary method for cleaning and disinfecting the root canal system (5). Sodium hypochlorite (NaOCl) is widely used as an irrigation solution due to its superior antimicrobial efficacy against biofilm formation (25) and its ability to dissolve organic tissue remnants (26). In our study, 91.6% of participants reported using NaOCl for root canal irrigation, a rate consistent with findings from other studies in the literature (27,28).

Although sodium hypochlorite is a widely preferred irrigant, it lacks the ability to dissolve hard tissue debris or the inorganic components of the smear layer formed during root canal shaping. EDTA is the most commonly used irrigant for this purpose (5,29). In our study, 68.2% of participants reported using EDTA, a rate higher than that reported in other studies in the literature (14,30). The use of EDTA was found to be significantly higher among younger dentists compared to their older colleagues ($p = 0.047$), which may be attributed to the lack of engagement with current literature among older practitioners after graduation. Additionally, the use of hydrogen peroxide increased with age and years of professional experience ($p = 0.015$). These findings are consistent with the results of a study conducted in 2015 (29).

Syringe irrigation remains the most commonly used technique for delivering irrigants into root canals among both endodontists and general dentists (15,31). The effectiveness of this method depends on the proximity of the needle to the apical end of the root canal. In endodontic treatment, two different types of needles are used for irrigation: open-ended and side-vented closed-ended needles (5). The optimal position for open-ended needles is reported to be 2–3 mm short of the working length, while for closed-ended needles, it is 1 mm short of the working length (32). Open-ended needles pose a higher risk of apical extrusion of irrigants (33). In our study, the use of special irrigation needles was significantly higher among younger dentists ($p < 0.05$) and those working in the private sector ($p = 0.004$). These findings suggest that

younger dentists may follow the literature more frequently after graduation compared to their older colleagues, or that dentists in general may not sufficiently update their knowledge after completing their education. The more frequent use of special irrigation syringes by dentists in private practice compared to those in public institutions may be due to limited access to this equipment in public healthcare settings.

In root canal treatment, after the cleaning and shaping of the canal system, achieving a completely hermetic seal is crucial to prevent oral pathogens from colonizing the root and periapical tissues, thereby reducing the risk of reinfection (34). Root canal sealers used in endodontic treatment fill gaps between the root filling material and dentin walls, covering canal irregularities and ensuring a hermetic seal along the entire canal, including the apical foramen. This seal prevents leakage, reducing the risk of residual bacteria spreading to periapical tissues and contributing to the healing of periapical lesions (35). Currently, a variety of endodontic sealers, including glass ionomer, zinc oxide-eugenol, resin, calcium hydroxide, silicone, and bioceramic-based materials, are used in clinical practice (36). In our study, no significant difference was found among age groups in terms of sealer preference. However, resin-based sealers were significantly more preferred compared to other types ($p < 0.05$), a finding consistent with literature data (14). Additionally, dentists in private practice preferred bioceramic-based sealers more frequently than those working in public institutions ($p < 0.05$). This difference may be attributed to limited access to these materials in public healthcare settings.

Numerous root canal obturation techniques have been described in the literature (37). Studies comparing the single cone technique and lateral compaction technique have found no significant difference in terms of radiographic healing outcomes (38,39). Similarly, studies comparing warm techniques with cold lateral compaction have also reported comparable healing results (40). In this study, the most frequently preferred root canal obturation technique was the single cone technique, used by 72.1% of participants. When comparing obturation techniques, it was observed that younger dentists preferred the cold lateral compaction technique more frequently than their older colleagues. This preference may be attributed to younger dentists having received more recent education and being more open to modern techniques. On the other hand, experienced dentists tend to rely on the methods they have used for many years, maintaining their clinical habits.

Conclusion

The results of our study indicate that older dentists use modern techniques less frequently compared to their younger colleagues. This may be due to their continued reliance on traditional methods and their failure to update the theoretical and practical knowledge acquired during their undergraduate education.

Supporting dentists in attending post-graduate practical and theoretical courses, seminars, and improving access to scientific publications could facilitate the adoption of modern techniques, even among more experienced practitioners. Additionally, enhancing access to modern equipment in public institutions and allowing longer appointment durations through the Central Physician Appointment System (MHRS) may increase the application of more current and effective approaches in root canal treatment.

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