Evaluation of Dentists' in Turkey Coronal Restoration Preferences for Endodontically Treated Teeth

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Abstract

Aim The aim of this study is to evaluate the upper restoration preferences of dentists in Turkey after performing root canal treatment with a questionnaire.

Material and method The survey questions consisted of demographic information, whether they performed root canal treatment regularly, whether they performed coronal restoration after root canal treatment, when they performed permanent coronal restorations, reasons for preference, in which cases they preferred extraction instead of root canal treatment, and the most frequently applied coronal restoration. The questionnaire was sent to the dentists electronically. Statistically, the data were analyzed with the Chi-square test. Significance was set to $p<0.05$.

Results 211 people participated in the survey. Most of the participants stated that they routinely performed root canal treatment, performed the coronal restoration immediately, and considered remaining amount of tissue in the selection of coronal restoration. For classes 1 to 3, resin-based composites were the most preferred, while post crown was the most preferred restoration in classes 4 and 5. Individuals without specialization were more likely to extract anterior and premolar teeth than those who specialized ($p<0.05$), those with over ten years of experience were more inclined to perform tooth extractions for all types of teeth than those with less than ten years of experience ($p<0.05$).

Conclusion The results of our study are useful in determining the missing aspects by evaluating the coronal restoration preferences of dentists after root canal treatment in Turkey. The use of indirect restorations is rare, but their use should be expanded.

Keywords Dentists, Endodontic treatment, Endodontically treated tooth, Postendodontic restoration, Survey

Introduction

The long-term viability of teeth that have undergone endodontic treatment depends on several factors. These include the number of adjacent teeth, occlusal contacts, position of the tooth in the arch, apical condition, collagen destruction, remaining dentin wall thickness, and permanent restoration type (1-3). Just because a root canal treatment is completed does not mark the end of patient care, and it is crucial to restore the tooth to its original form, function, and appearance. After the endodontic treatment, the coronal restoration should restore form, function, and aesthetics and prevent bacterial microleakage into the root canal system. Additionally, it should protect the tooth from potential fractures and caries in the future (4-6).

Choosing the right coronal restoration and ensuring its quality is crucial for the success of a tooth that has undergone endodontic treatment (7, 8). However, deciding on the best restoration option can be challenging for dentists, given the various treatment options available. Factors such as a dentist's clinical experience and postgraduate education may also influence their decision-making process (9). Although a dentist's skill may improve with time, using new materials requires proper training and up-to-date knowledge to ensure optimal application (9-11).

For years, amalgam/composite fillings, metal alloys, and dental ceramics were commonly used for restoring root canal-treated teeth. However, due to the toxic effects of amalgam and the high cost of precious metal alloys, alternative materials are now preferred (12). Additionally, with the importance of preserving the remaining tooth structure and aesthetic expectations, there has been an increase in the variety of materials and restorations available for coronal restorations after endodontic treatment (13). Composite resin is a popular choice due to its ease of application, acceptable aesthetics, and controllability. Furthermore, studies have shown that composite resins offer better support than amalgams when used for restoring root canal-treated teeth (14). Instead of amalgam cores and cast metal posts, composite and fiber posts are now used, along with CAD-CAM supported crowns, inlays, onlays, and endocrons, which provide superior aesthetic results (13). Advancements in technology have brought about new dental products and materials to the market, resulting in an increase in the options available for restoring teeth that have limited intact tissue (15). Consequently, there has been a shift in the coronal restoration preferences of dentists following endodontic treatment.

Dentists' preferred treatment concepts and materials for coronal restorations of endodontically treated teeth have been studied in various countries (16-19). These studies have looked at post-core preferences (20), types of prosthetic restoration (16), and overall restoration preferences (21). However, there is a gap in the literature regarding coronal restoration preferences of Turkish

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dentists. This study aims to fill that gap by investigating the preferred coronal restoration types for endodontically treated teeth among dentists in Turkey, including both general and specialized practitioners.

The null hypothesis to be tested;

1. The coronal restoration preferred by Turkish dentists does not change depending on the amount of tissue remaining in endodontically treated teeth
2. The institution where the dentist works, the year of experience, age, gender, and expertise do not affect the preferred coronal restoration type.

Material and Methods

The study was approved by the Non-Interventional Clinical Research Ethics Committee of Niğde Ömer Halisdemir University (ethical no:119/2022), ensuring ethical considerations were met. Participants in the study included general dentists as well as specialists in restorative, endodontic, pedodontic, and prosthetic dentistry practicing in Turkey. However, specialists in orthodontics, oral and maxillofacial surgery, periodontology, and oral radiology were excluded from the study. The sample size was determined using the Raosoft web-based sample size calculation software, with an 85% confidence interval, 5% alpha error, and a required population size of 50000, resulting in a necessary participant count of approximately 206.

The survey is divided into three parts. The first part informs the participants about the study and obtains their consent. The second part of the survey asks for the participants' demographic information such as age, gender, years of experience as a physician, and their workplace. The third and final part of the survey asks if the participants regularly perform root canal treatments, if they usually perform coronal restorations after root canal treatments, when they perform permanent coronal restorations on teeth that had root canal treatments, and the reason behind their preference for permanent coronal restorations on teeth that had root canal treatments.

Table 1: A classification system with 5 categories based on the amount of healthy tooth tissue left after endodontic treatment and the number of remaining axial cavity walls, as defined by Naumann, Blankenstein

Class	Description
Class 1	It is the case where only the endodontic access cavity is opened and all four axial cavity walls are present.
Class 2	It only covers cavities with a loss of wall mesio-occlusally or disto-occlusally.
Class 3	It includes teeth with loss of 2 walls, mesial, occlusal, and distal.
Class 4	It covers single-walled situations where only the buccal or lingual cavity wall remains.
Class 5	The crown structure includes teeth that have lost a lot of substance and completely lost all their axial cavity walls.

In the following questions, we used a classification system with 5 categories based on the amount of healthy tooth tissue left after endodontic treatment and the number of remaining axial cavity walls (Table 1), as defined by Naumann, Blankenstein (22). We asked them which class of anterior, premolar, and molar teeth would they prefer to extract instead of performing a root canal treatment if coronal restoration is not possible. Additionally, we asked about the most commonly applied coronal restoration for each class of canal-treated teeth.

Statistical Analysis

Jamovi software (Version 2.3.21) was used for the statistical analysis. A descriptive analysis was performed. The relationship between demographic attributes and responses was examined with the Chi-square test, and significance was set to $p<0.05$.

Results

The study had 211 participants with an average age of 33.7±9.8 years. Of the participants, 63.5% were female and 53.6% had no specialization. Most participants (73%) had less than 10 years of experience. While 47.4% worked in private dentistry, 24.6% worked at a university (Table 2).

Table 2: Demographic attributes of participants

Gender	Overall (N=211)
Female	134 (63.5%)
Male	77 (36.5%)
Age	
Mean (SD)	33.7 (9.8)
Range	24.0 - 74.0
Age range	
≤30	107 (50.7%)
>30	104 (49.3%)
Speciality	
No	113 (53.6%)
Yes	98 (46.4%)
Experience	
≤10	154 (73.0%)
>10	57 (27.0%)
Workplace	
University	52 (24.6%)
Public Health	59 (28.0%)
Private Dentistry	100 (47.4%)

The majority of participants reported attending scientific meetings, such as congresses and symposiums, with a percentage of 87.68%. Additionally, 86.26% routinely performed root canal treatments, and 93.36% performed coronal restoration after the treatment (Fig 1). Moreover, 63.51% of participants stated that they perform a permanent coronal restoration of a root canal treated tooth immediately (Fig 2). The most important factor for selecting a permanent coronal restoration was the amount of remaining tissue, with a percentage of 88.00%, while the least important factor was whether there would be a supporting tooth for the fixed prosthesis, with only 1.5% (Fig 3). Class 2 restorations were the most frequent scenario with 54.04%, while class 1 was the least common with 0.00% (Fig 4). For classes 1 to 3, resin-based composites were

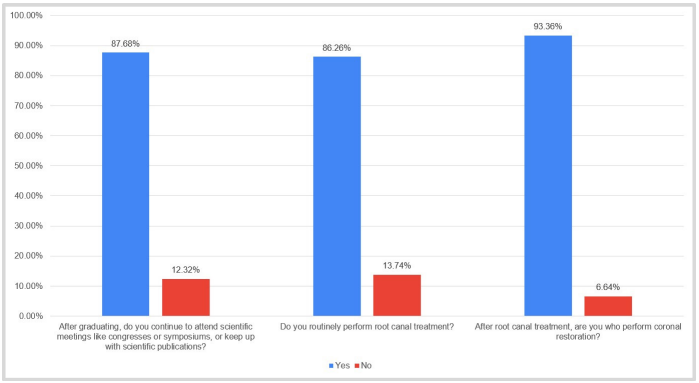

Figure 1: The responses to general questions about coronal restoration and root canal treatment choice.

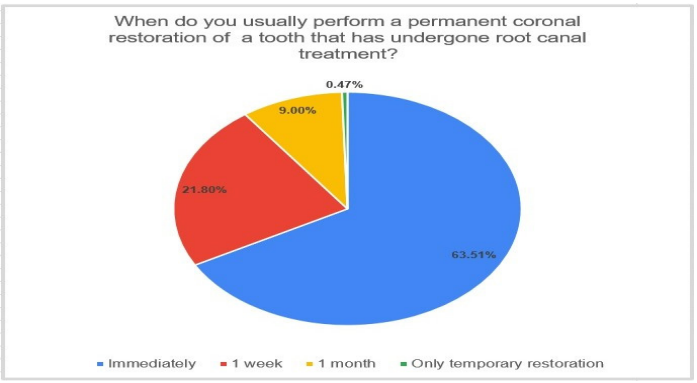

Figure 2: The time frame for practitioners between root canal treatment and coronal restoration.

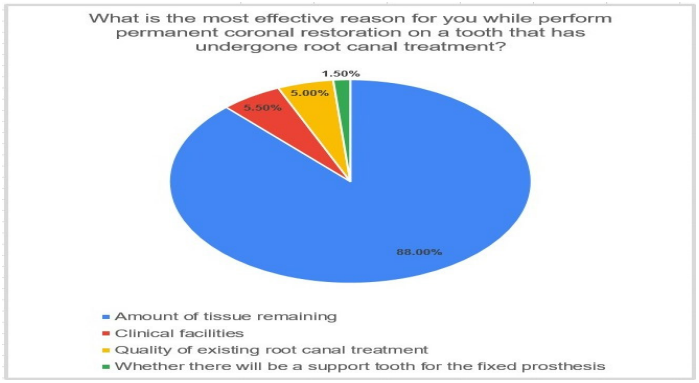

Figure 3: The responses to the question regarding what if the most effective reason for choosing permanent coronal restoration.

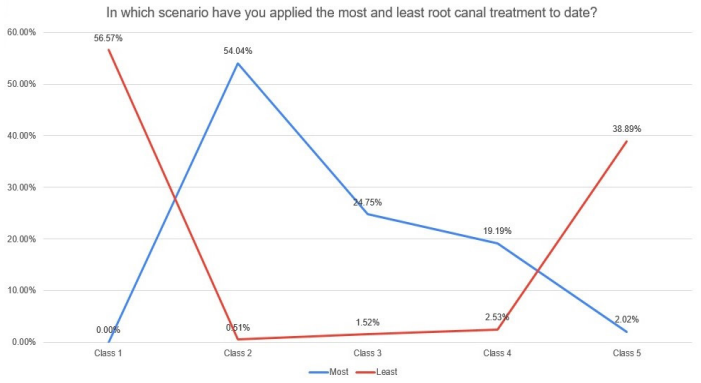

Figure 4: The responses to the question regarding the scenarios which they applied most and least root canal treatment.

the most preferred, while post crown was the most preferred restoration in classes 4 and 5 (Fig 5).

Individuals without specialization were more likely to extract anterior and premolar teeth than those who specialized ($p<0.05$). However, no significant difference was found for molar teeth ($p>0.05$). In addition, those with over ten years of experience were more inclined to perform tooth extractions for all types of teeth than those with less than ten years of experience ($p<0.05$), as shown in Table 3.

The choice of coronal restorations did not differ significantly based on specialization ($p>0.05$). However, practitioners from Public Health were more likely to use amalgam in scenarios involving Classes 2 to 4 ($p<0.05$) compared to other workplaces. There was no significant difference in the use of restorations for Classes 1 and 5 scenarios ($p>0.05$) (Table 4).

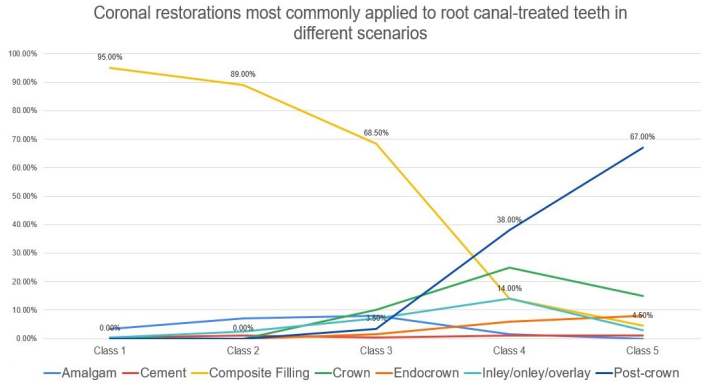

Figure 5: The responses to the question regarding the coronal restorations which they applied most and least in different scenarios.

Discussion

The success of a root canal treatment depends on several crucial factors, including a thorough understanding of the tooth's structure and anatomy, accurate diagnosis, effective treatment planning, complete disinfection, adequate filling of the root canal, and proper coronal restorations (23). After filling, small particulate molecules can still penetrate the root canal, so it is crucial to have a strong coronal restoration to protect against chemical, bacterial, thermal, and mechanical factors that may affect the root canal system (24). Our study aimed to investigate the various approaches of dentists in Turkey when faced with different coronal restoration scenarios. In the light of the findings, our hypotheses "The coronal restoration preferred by Turkish dentists does not change depending on the amount of tissue remaining in endodontically treated teeth." and "The institution where the dentist works, the year of experience, age, gender, and expertise do not affect the preferred coronal restoration type." were rejected.

Research shows that performing permanent restoration during the first session of root canal treatment can increase the lifespan of the treated tooth (25-28). Delaying the permanent coronal restoration, on the other hand, may increase the risk of endodontic failure (4, 29, 30). This is because temporary filling

Table 3: Comparison of the preference of tooth extraction in different classes instead of root canal treatment according to specialty and workplace since coronal restoration cannot be performed

	Speciality			Experience			
	Yes (N=88)	No (N=111)	p value	<11 (N=145)	>10 (N=54)	p value	Total (N=199)
Anterior			0.010*			0.006*	
RCT	69.0 (78.4%)	64.0 (57.7%)		101.0 (69.7%)	32.0 (59.3%)		133.0 (66.8%)
5	10.0 (11.4%)	27.0 (24.3%)		29.0 (20.0%)	8.0 (14.8%)		37.0 (18.6%)
4+5	7.0 (8.0%)	19.0 (17.1%)		15.0 (10.3%)	11.0 (20.4%)		26.0 (13.1%)
1+2+3+4+5	2.0 (2.3%)	1.0 (0.9%)		0.0 (0.0%)	3.0 (5.6%)		3.0 (1.5%)
Premolar			0.002*			0.005*	
RCT	61.0 (69.3%)	52.0 (46.8%)		84.0 (57.9%)	29.0 (53.7%)		113.0 (56.8%)
5	18.0 (20.5%)	40.0 (36.0%)		48.0 (33.1%)	10.0 (18.5%)		58.0 (29.1%)
4+5	5.0 (5.7%)	18.0 (16.2%)		12.0 (8.3%)	11.0 (20.4%)		23.0 (11.6%)
3+4+5	2.0 (2.3%)	0.0 (0.0%)		1.0 (0.7%)	1.0 (1.9%)		2.0 (1.0%)
2+3+4+5	0.0 (0.0%)	1.0 (0.9%)		0.0 (0.0%)	1.0 (1.9%)		1.0 (0.5%)
1+2+3+4+5	2.0 (2.3%)	0.0 (0.0%)		0.0 (0.0%)	2.0 (3.7%)		2.0 (1.0%)
Molar			0.076			0.004*	
RCT	45.0 (51.1%)	39.0 (35.1%)		63.0 (43.4%)	21.0 (38.9%)		84.0 (42.2%)
5	33.0 (37.5%)	43.0 (38.7%)		59.0 (40.7%)	17.0 (31.5%)		76.0 (38.2%)
4+5	8.0 (9.1%)	25.0 (22.5%)		23.0 (15.9%)	10.0 (18.5%)		33.0 (16.6%)
3+4+5	0.0 (0.0%)	1.0 (0.9%)		0.0 (0.0%)	1.0 (1.9%)		1.0 (0.5%)
2+3+4+5	0.0 (0.0%)	1.0 (0.9%)		0.0 (0.0%)	1.0 (1.9%)		1.0 (0.5%)
1+2+3+4+5	2.0 (2.3%)	2.0 (1.8%)		0.0 (0.0%)	4.0 (7.4%)		4.0

*indicates significance, RCT: Only Root Canal Treatment

materials may not fully seal off bacteria between sessions (4). In our study, 63.51% of participants reported performing coronal restoration during the first session. Similarly, Topalan (31) found that the majority of participants in their study also immediately performed coronal restoration after endodontic treatment.

When deciding on a permanent restoration for a tooth that has undergone endodontic treatment, there are several factors to consider. These include the amount of remaining tooth structure, the position of the tooth, and the cost (32). In this survey of dental professionals, 88% cited the amount of remaining tissue as the most important factor in their choice of coronal restoration. When asked about the restoration of endodontically treated teeth, the majority of participants (77.4%) reported that the remaining tooth structure was the main factor in their decision to use a fiber post or custom-made post and core system (33). This finding is consistent with other studies, such as Usta, Cömert-Pak (34)'s survey where 87% of respondents cited remaining tooth structure as the most important factor in post-endodontic restoration. Excessive material loss can weaken the tooth's resistance to incoming forces, making it crucial to consider the amount of remaining tooth structure when choosing a restoration method.

The survey results showed that Class 5 and Class 1 teeth are the least likely to receive canal treatment. Practitioners are more likely to notice caries on the occlusal surface, which may provide to the caries being treated early to prevent progression and reach of the pulp. Diagnosing occlusal caries lesions at an early stage can also prevent caries from appearing on the approximal surfaces (35). This may explain why Class 1 teeth receive less root canal treatment. Access cavity preparation can negatively affect fracture resistance if marginal ridges in the occlusal region are lost (36). It is possible that participants preferred extraction over root canal treatment for Class 5 teeth due to the greater loss of substance and more laborious and additional procedures required for restoration. When deciding on restoration for a tooth that has undergone endodontic treatment, the amount of healthy tooth tissue remaining is the most critical factor to consider. This is because the amount of remaining tooth tissue directly affects the tooth's ability to resist fractures. Posterior teeth, which experience high levels of force during chewing, are more susceptible to fractures. Meanwhile, esthetic considerations are more important for anterior teeth, which are less prone to fractures (37-39). If the remaining tooth tissue after root canal treatment is likely to be very weak, extraction may be preferred over root canal treatment. Additionally, the location of the tooth in the arch also plays a role in the choice of restoration, as the forces acting on restorations in the anterior and posterior regions are different (1).

Most participants indicated that they would opt for root canal treatment in all cases. According to Sambrook and Burrow (40), the position of the tooth in the arch and the type of restoration planned can influence the restorative decision. The study also found that root canal treatment was more likely to be applied in the anterior region due to the greater aesthetic need. General dentists tend to prefer tooth extraction, while specialists in anterior and premolar teeth prefer root canal treatment. Further, Demarco,

Table 4: Comparison of the most commonly applied coronal restoration types to root canal-treated teeth in different classes according to specialty and workplace.

	Speciality			Workplace				
	Yes (N=88)	No (N=106)	p value	University (N=50)	Public Health (N=50)	Private Dentistry (N=94)	p value	Total (N=194)
Class 1			0.446				0.414	
Amalgam	2.0 (2.3%)	5.0 (4.7%)		1.0 (2.0%)	3.0 (6.0%)	3.0 (3.2%)		7.0 (3.6%)
Cement	0.0 (0.0%)	1.0 (0.9%)		0.0 (0.0%)	1.0 (2.0%)	0.0 (0.0%)		1.0 (0.5%)
Composite Filling	85.0 (96.6%)	99.0 (93.4%)		49.0 (98.0%)	45.0 (90.0%)	90.0 (95.7%)		184.0 (94.8%)
Crown	0.0 (0.0%)	1.0 (0.9%)		0.0 (0.0%)	0.0 (0.0%)	1.0 (1.1%)		1.0 (0.5%)
Inley/onley/overlay	1.0 (1.1%)	0.0 (0.0%)		0.0 (0.0%)	1.0 (2.0%)	0.0 (0.0%)		1.0 (0.5%)
Class 2			0.308				< 0.001*	
Amalgam	4.0 (4.5%)	10.0 (9.4%)		1.0 (2.0%)	11.0 (22.0%)	2.0 (2.1%)		14.0 (7.2%)
Cement	0.0 (0.0%)	2.0 (1.9%)		0.0 (0.0%)	1.0 (2.0%)	1.0 (1.1%)		2.0 (1.0%)
Composite Filling	82.0 (93.2%)	91.0 (85.8%)		48.0 (96.0%)	38.0 (76.0%)	87.0 (92.6%)		173.0 (89.2%)
Inley/onley/overlay	2.0 (2.3%)	3.0 (2.8%)		1.0 (2.0%)	0.0 (0.0%)	4.0 (4.3%)		5.0 (2.6%)
Class 3			0.158				0.002*	
Amalgam	2.0 (2.3%)	14.0 (13.2%)		1.0 (2.0%)	10.0 (20.0%)	5.0 (5.3%)		16.0 (8.2%)
Cement	0.0 (0.0%)	1.0 (0.9%)		0.0 (0.0%)	1.0 (2.0%)	0.0 (0.0%)		1.0 (0.5%)
Composite Filling	65.0 (73.9%)	70.0 (66.0%)		39.0 (78.0%)	36.0 (72.0%)	60.0 (63.8%)		135.0 (69.6%)
Crown	8.0 (9.1%)	10.0 (9.4%)		4.0 (8.0%)	2.0 (4.0%)	12.0 (12.8%)		18.0 (9.3%)
Endocrown	2.0 (2.3%)	1.0 (0.9%)		2.0 (4.0%)	0.0 (0.0%)	1.0 (1.1%)		3.0 (1.5%)
Inley/onley/overlay	7.0 (8.0%)	7.0 (6.6%)		1.0 (2.0%)	1.0 (2.0%)	12.0 (12.8%)		14.0 (7.2%)
Post-crown	4.0 (4.5%)	3.0 (2.8%)		3.0 (6.0%)	0.0 (0.0%)	4.0 (4.3%)		7.0 (3.6%)
Class 4			0.473				0.003*	
Amalgam	0.0 (0.0%)	3.0 (2.8%)		0.0 (0.0%)	3.0 (6.0%)	0.0 (0.0%)		3.0 (1.5%)
Cement	1.0 (1.1%)	1.0 (0.9%)		1.0 (2.0%)	0.0 (0.0%)	1.0 (1.1%)		2.0 (1.0%)
Composite Filling	10.0 (11.4%)	18.0 (17.0%)		4.0 (8.0%)	16.0 (32.0%)	8.0 (8.5%)		28.0 (14.4%)
Crown	21.0 (23.9%)	27.0 (25.5%)		13.0 (26.0%)	11.0 (22.0%)	24.0 (25.5%)		48.0 (24.7%)
Endocrown	7.0 (8.0%)	5.0 (4.7%)		3.0 (6.0%)	1.0 (2.0%)	8.0 (8.5%)		12.0 (6.2%)
Inley/onley/overlay	15.0 (17.0%)	12.0 (11.3%)		9.0 (18.0%)	3.0 (6.0%)	15.0 (16.0%)		27.0 (13.9%)
Post-crown	34.0 (38.6%)	40.0 (37.7%)		20.0 (40.0%)	16.0 (32.0%)	38.0 (40.4%)		74.0 (38.1%)
Class 5			0.464				0.177	
Cement	1.0 (1.1%)	1.0 (0.9%)		1.0 (2.0%)	0.0 (0.0%)	1.0 (1.1%)		2.0 (1.0%)
Composite Filling	5.0 (5.7%)	4.0 (3.8%)		2.0 (4.0%)	6.0 (12.0%)	1.0 (1.1%)		9.0 (4.6%)
Crown	12.0 (13.6%)	16.0 (15.1%)		6.0 (12.0%)	7.0 (14.0%)	15.0 (16.0%)		28.0 (14.4%)
Endocrown	11.0 (12.5%)	5.0 (4.7%)		6.0 (12.0%)	2.0 (4.0%)	8.0 (8.5%)		16.0 (8.2%)
Inley/onley/overlay	3.0 (3.4%)	3.0 (2.8%)		2.0 (4.0%)	0.0 (0.0%)	4.0 (4.3%)		6.0 (3.1%)
Post-crown	56.0 (63.6%)	77.0 (72.6%)		33.0 (66.0%)	35.0 (70.0%)	65.0 (69.1%)		133.0 (68.6%)

*indicates significance (p<0.05)

Baldissera (11) stated that postgraduate education can influence treatment choices, with specialists being more familiar with the literature and more willing to apply new technologies. Rabi and Rabi (41) also noted that treatment choices are influenced by experience duration.

Composite resin restoration is a popular choice for many reasons, including their natural appearance, strong bond, minimal preparation required, cost-effectiveness, and ability to strengthen remaining tooth tissue. Studies have shown that composite restorations have a high success rate in teeth with adequate remaining structure (33, 42, 43). In fact, a survey found that composite resin is the most preferred material across all regions (34). One reason for this preference may be due to the fact that composite resin bonding is often sufficient with multiple walls present in the tooth, eliminating the need for additional laboratory procedures. Overall, composite resin restorations are a reliable and effective option for Class 1, 2, and 3 teeth after root canal treatment. Consistent with this study, previous studies found that dentists working at public institutions tended to use more amalgam, maybe due to workload (44, 45).

Restoring damaged teeth after root canal treatment is often done using a method called post core application (46). This

helps prevent breakage in the buccal and lingual walls, which can occur due to loss of the mesial and distal walls that reduce the tooth's resistance to occlusal forces (47). Restoration with fiber posts has been proposed and successfully used to prevent this issue. In fact, a study showed an 8-year survival rate with post placement and crown restoration (48). A meta-analysis found that the presence of a post-core greatly improves the survival rate of root canal treated teeth (49). It is recommended to use post-cores in cases of excessive coronal loss (50, 51). Participants in the study preferred the post-core more frequently in Class 4 and 5 cases.

Our study had certain limitations, one of which was that we were unable to determine the response rate of participants due to the web-based survey method used. In addition, it is important to note that the classification based on Naumann, Blankenstein (22) included all teeth and may vary in approach between anterior and posterior teeth. On a positive note, the study's generalizability is increased as it was not conducted at a single center.

Conclusion

Dentists prefer to use composite resin for class 1, 2, and 3 scenarios where there is less tissue loss. For scenarios where there is more tissue loss, such as class 4 and 5 scenarios, post-crowns are the preferred option. The amount of tissue loss is the most important factor when choosing a restoration method. Dentists with more experience and general dentists tend to extract more teeth in cases where there is significant tissue loss. Physicians in public institutions generally prefer amalgam over those working in private or university institutions. The use of inlay, onlay, overlay, and endocrown restorations is infrequent, but indirect restorations may be a better option and their use should be expanded.

Declarations

Author Contributions: *Conception/Design of Study- S.K.K., F.P.H.; Data Acquisition- S.K.K., Ö.H.; Data Analysis/Interpretation- S.K.K., F.P.H., Ö.H.; Drafting Manuscript- S.K.K., F.P.H.; Critical Revision of Manuscript- S.K.K., F.P.H.; Final Approval and Accountability- S.K.K., F.P.H.; Material and Technical Support- S.K.K.; Supervision- S.K.K., Ö.H.*

Conflict of Interest: *Authors declared no conflict of interest.*

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