

## Review

# Choice of Restorative Materials by Dental Practitioners and Students in Saudi Arabia for Endodontically Treated Teeth: A Systematic Review

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## Abstract

**Background:** There are several elements to consider when determining the optimal procedure for restoring teeth that have undergone endodontic treatment, including the choice and requirement of a post, the kind of coronal restoration, how much coronal structure is still there, and the kind of cementing agent. The ideal restoration procedure for teeth that have undergone endodontic treatment is yet unknown. The goal of this systematic review was to evaluate the restorative material choices and factors that affect the decision-making on endodontically treated teeth (ETT) among dental professionals and students in the Kingdom of Saudi Arabia.

**Methods:** Studies that evaluated the choice or preference of dental professionals for restorative materials for teeth that had undergone endodontic treatment were chosen from surveys that were published between 2012 and 2022 in English. Selected keyword searches were conducted in the Science Direct, PubMed, and Google Scholar databases. The data (theme-related questions and response rates for each survey question) were extracted using a standardized outline, and the likelihood of bias was evaluated. The information gathered was subjected to descriptive analysis.

**Results:** There were 11 articles in total, encompassing 2192 respondents. The response rates ranged from 30% to 98%. The study population consisted of general dental practitioners (n = 1018), followed by dental students (n = 598), specialists (n = 475), and 101 dental surgeons. The years of experience range from 1 to > 30 years, with the majority claiming to have fewer than 10 years. Moreover, 55% of the studies preferred prefabricated posts, such as fiber posts following metal posts. Most of the respondents preferred resin-based cementing agents (22% to 82%). Over 60% of respondents chose composite resin over amalgam as the material for the core foundation

**Conclusion:** The study results from Saudi Arabian data showed that dentists favored using prefabricated posts, such as fiber and metal-based posts, to restore ETTs and resin-based cementing agents. The preferred material for the core foundation built for ETT by regular dentists, specialists, and students is regarded as composite. The amount of coronal tooth structure that is still present is crucial when choosing the post type and restorative material.

**Keywords:** *endodontic treatment, restoration, post, cement, systematic review*

## Introduction

Dental restorations are used to replace missing tooth structure, typically brought on by dental caries but not exclusively, and to restore its normal function, integrity, and morphology. Endodontic treatment is carried out for teeth affected by caries, repeated restorations, and fractures. Permanent restorations on ETT are more effective than temporary ones (1, 2). Various strategies have been suggested for the restoration of ETT. The approach known as "post and core" is the typical way to restore ETT. A post is a type of dental restoration that is inserted into the root of a severely injured tooth. It offers additional retention and aids in keeping the core build-up in place. The use of post and core, partial or full crowns, direct resin composite fillings, or amalgam fillings are some of these therapeutic options for core build-up, and a variety of dental materials have been utilized. Amalgam, Glass ionomer (GI), resin-modified GI cement, cermet, and composite resin are among the materials utilized for core build-up (3, 4).

In modern dentistry, the restoration of teeth undergoing endodontic treatment continues to be extensively considered. Although the prognosis of endodontically treated teeth can be affected in many ways, the major issues critical for the choice of whether to place a post and the core type used is the type of tooth and the degree of the remaining dental matter after caries removal and endodontic treatment are accomplished (5). However, characteristics specific to dentists, including clinical experience and postgraduate study, might also have an impact on the decision-making process (6). In order to offer trustworthy scientific information, it is important to take dentists' preferences into account and analyse the various treatment alternatives in a clinical setting. However, there are several *in vitro* studies that are published in the scientific literature that are mostly material-focused, non-comparable, and somewhat confusing. There isn't much well-randomized, controlled clinical research in this field. Even though ETT has been extensively researched in descriptive studies, the body of knowledge regarding the restorative materials, factors influencing decision-making and treatment methods, as well as restoring material preferences, is still debatable. Prior findings suggest that each dentist develops a special, experience-based therapeutic concept. The use of surveys is essential for comprehending and assessing post-endodontic restorative therapy methods and materials used for it. Additionally, considerable survey research has been done on the methods and preferences of dental professionals in various Saudi Arabian

provinces when it comes to repairing ETT. In this review, we sought to examine current restoration methods and treatments as well as decision-making variables.

## Materials and Methods

### *Definition of outcomes and inclusion criteria*

All published survey cross-sectional studies conducted between 2012 and 2022 and including dentists' and students' surveys related to restoration material preferences, choices, and factors affecting them were included in the systematic review. The respondents of the surveys answered questionnaires about the use of intracanal posts and type of post, different cementing agents, or choices of materials to restore the coronal portion of the tooth, were assessed. We have included only cross-sectional survey studies, which gathered information from a set group of respondents (dentists, dental specialists, and students) to learn more and get insights into ETT treatment preferences for restorative materials and factors affecting the choices of respondents. Studies with different study designs (besides survey studies) or without an evaluation of the choices or preferred restorative materials, posts, or luting agents were excluded.

### *Search strategy*

An extensive electronic database search was performed using PubMed/Medline, Google Scholar, and Science Direct to identify the published research articles collected after 2012. Based on our determined outcomes, we retrieved the relevant keywords from a brief manual screening within the potentially included studies to design the most suitable search term. We used the following keywords in free text and medical subject headings (MeSH): "community surveys", "questionnaire surveys", "dental restoration", "material", "restorative material", "restoration", "luting agent", "cementing agent", "post", "cast post", "core build up", "endodontically treated" and "Saudi Arabia", "Kingdom of Saudi Arabia". Our search strategy was limited to the title and abstract of the search results to utilize all the relevant studies only. All of these findings were saved to an Endnote library so that we could find and use any duplicate entries across the many databases we searched. In addition, we manually searched every related article area in PubMed, as well as the references of the included studies and pertinent reviews, in the hopes of finding any research that the primary electronic search approach

could have been overlooked. Hand searches were conducted on the reference of all included papers and published systematic reviews on restorative treatment. All steps of this systematic review were conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (7).

### Screening and extraction

We used a double screening strategy, one for screening titles and abstracts and the other for screening full texts, to maintain high quality in this important process. Full texts of publications of possibly eligible studies were read and their relevance to the scope of this systematic review was judged. An orderly extraction sheet that was pertinent to our desired outcomes was created after making sure that all pertinent articles were included. The following data was accumulated using a standard outline: baseline characteristics about the selected publication (author and year of publication), the study's characteristics (setting, regions, sample size, response rate), the respondents' characteristics (experience years and professional level: general practitioners, specialist/consultants, or students), questions about ETT restorations, and the factors influencing each question's choice and response rate were all extracted and entered into pre-built tables.

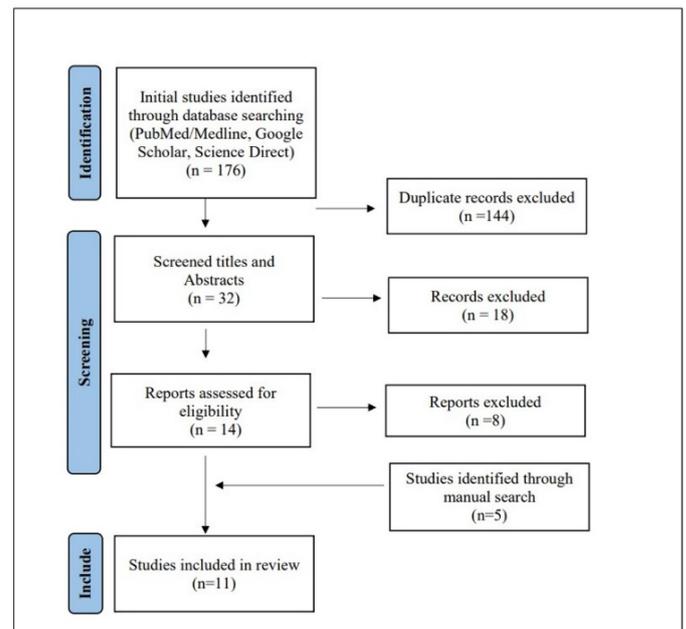
### Quality assessment

The quality and risk of bias of the included research were evaluated using a risk of bias assessment in cross-sectional surveys of attitudes and practice developed by Agarwal (8). The following areas were taken into consideration: the sample's representativeness; the response rate's sufficiency; the amount of missing data among completed questionnaires; the performance of pilot testing; and the survey instrument's established validity.

## Results

### Search results

The PRISMA Diagram (**Figure 1**) shows the study selection flowchart. A total of 176 articles were found in the literature search, and 5 more studies were found through manual search and references to the studies that were included. Duplicates were removed using Endnote X8. If abstracts were found relevant, the full-text article was reviewed. Of the 14 articles assessed, 11 met all the criteria for inclusion and were included and investigated in the review.



**Figure 1:** Flow chart showing the included studies using PRISMA guideline

### Results of quality assessment

**Table 1** presents the risk of biased judgment for the included studies. All of the studies (100%) were judged as "Unclear" due to missing information within the completed survey. The adequacy of the response data is not sufficient for two studies and is judged as "Probably no." Six studies (54.5%) conducted pilot studies (Definitely yes). All the studies have either used validated survey tools or conducted validity tests for pilot study data. Those studies were judged as "Definitely yes" (100%).

Table 1: Summary of the results of bias assessment for survey studies

Author	Representativeness of the sample	Adequacy of response rate	Missing data within completed questionnaires	Conduct of pilot testing	Established validity of the survey instrument
Zahran et al.,2022	Probably yes	Probably yes	Unclear	Definitely no	Definitely yes
Pani et al., 2022	Probably yes	Probably yes	Unclear	Definitely yes	Definitely yes
Alobaidi et al.,2021	Probably yes	Definitely yes	Unclear	Definitely no	Definitely yes
Shetty et al.,2021	Probably yes	Probably yes	Unclear	Definitely yes	Definitely yes
Iqbal et al.,2021	Probably yes	Probably yes	Unclear	Definitely yes	Definitely yes
AlZain et al., 2019	Probably yes	Definitely yes	Unclear	Definitely no	Definitely yes
Alenzi et al., 2018	Probably yes	Probably yes	Unclear	Definitely no	Definitely yes
Alasmari et al.,2018	Probably yes	Probably yes	Unclear	Definitely yes	Definitely yes
Alsughair et al.,2018	Probably yes	Probably no	Unclear	Definitely yes	Definitely yes
Akbar., 2015	Probably yes	Probably yes	Unclear	Definitely yes	Definitely yes
Habib et al., 2014	Probably yes	Probably no	Unclear	Definitely no	Definitely yes

Probably yes and Definitely yes were considered as "Low risk of bias" and Probably no and Definitely no were considered as "High risk of bias".

### Characteristics of the study included

The baseline characteristics of the included study and study participants are shown in **Table 2**, and **Table 3** shows the findings of questionnaires about restorative material preferences, choices, and factors affecting them. This systematic review covered a total of 11 surveys (9-19) investigations that were carried out in Saudi Arabian regions and involved a total of 2192. The majority of the research (72.7%) was conducted in the settings of dental

practitioners in different regions of Saudi Arabia and published between 2012 and 2022. In the included surveys of dentists and dental students, the sample sizes ranged from 98 to 374 respondents, while the response rates ranged from 30% to 98%. The study population consisted primarily of general dental practitioners (n = 1018), followed by dental students (n = 598), specialists (n = 475), and 101 dental surgeons. The years of experience range between 1 to > 30 years, with the majority claiming to have fewer than 10 years.

Table 2: Baseline characteristics of the included studies in this review.

Author	Setting	Region	Number of respondents	Response rate	Study design	Professional level	Experience level/Mean experience time
Zahran et al., 2022	Dentists	Jeddah	138	35%	cross-sectional survey design	GP=45 Specialist =93	NR
Pani et al., 2022	Dental Students	Riyadh	267	NR	cross-sectional survey design	NR	NR
Alobaidi et al., 2021	Dentists	Riyadh	374	NR	cross-sectional survey design	GP= 278 Specialist = 96	<10 years = 75%, >10 years = 25%
Shetty et al., 2021	Dental practitioners	Jeddah and Makkah	202	NR	cross-sectional survey design	GP = 120 Specialist = 82	NR
Iqbal et al., 2021	Dental Students.	Sakaka	98	75%	cross-sectional survey design	NR	NR

<b>AlZain., 2019</b>	Dental students and new graduates	Riyadh	233	98%	cross-sectional survey design	NR	NR
<b>Alenzi et al., 2018</b>	Dental practitioners anonymously throughout Saudi Arabia (five regions)	North, South, West, East, and Centre regions	164	54.70%	cross-sectional survey design	GP = 109 Specialist = 55	Between 1 and 35 years
<b>Alsughair et al., 2018</b>	Dental practitioners registered in the Saudi dental society	NR	238	40%	cross-sectional survey design	GP = 238	NR
<b>Alasmari et al., 2016</b>	Dentists	Abha	121	NR	cross-sectional survey design	General dental surgeon = 101 Specialist = 20	NR
<b>Akbar et al., 2015</b>	Clinical Dentists	North Region	153	60%	cross-sectional survey design	GP = 124 Specialist = 29	Mean time - 7.5 years
<b>Habib et al., 2014</b>	Dentists	Riyadh	204	30%	cross-sectional survey design	GP = 104 Specialist = 100	Mean time - 9.7 years

*General Practitioners (GP); Not reported (NR).*

Prefabricated posts, fiber posts, both types of posts, non-metal posts, and custom-cast posts were among the types of posts employed in the included studies (9, 11, 12, 15, 17-19). Cast metal posts were mentioned in two different studies (9, 12). The preferences of dentists for various cementing agents were reported in five investigations (9, 12, 15, 18, 19). The preferences were for resin-based cementing agents, GI, zinc phosphate, and resin-modified GI cement, respectively. The preferred material for the core foundation by dentists and students was composite resins compared to amalgam, and the choice of composite resin by respondents ranged over 60% (9-11, 15-19). One included survey (13) reported that the

participants equally preferred both amalgam and composite as a posterior restorative material. Most of the included studies (10, 12-17) reported the factors influencing the choice of respondents for choosing the ETT technique and restorative material. The amount of remaining tooth structure was the most reported answer, as well as patient preference, ease of use, cavity preparation, and cost preferences. Furthermore, two surveys queried respondents about the most typical ETT failures: crown fracture, endodontic failure, and loss of retention (18, 19). Another study (10) reported the drawbacks of different restorative materials.

**Table 3: Summary of the outcomes of the included studies in this review.**

Author	Type of post	Type of cement	Type of core	Factors influencing the choice of restorative material	Factors for the failure of ETT
<b>Zahran et al., 2022</b>	non-metallic post (for anteriors and molars) cast post and core (for molars), non-metallic post, and cast post and core (for premolars)	non-metallic PFP: resin cement (82%), GI cement (8.7%); metallic PFP resin cement: GI (31%); cast post and core: GI (34.8%) cement, resin cement (30.4%).	composite resin	NR	NR
<b>Pani et al., 2022</b>	NR	NR	composite resin compared to amalgam	easy to use, properties of the material, cost, patients' preference, and cavity preparation	NR

<b>Alobaidi et al., 2021</b>	PfP (55.1%): fiber-reinforced: 50.5% MP: 21.7% composite: 16.3% ceramic: 11.5% custom cast posts (44.9%)	NR	when more than 50% crown is remaining; composite:58% amalgam: 26.2%	NR	NR
<b>Shetty et al., 2021</b>	PfP: fibre post: GP= 11.38%, Specialist =4.95%, MP: GP= 8.41%, Specialist = 0% cast MP: GP= 11.38%, Specialist =4.95%	GI; GP= 20 (9.9%), SP=0%, RC; GP = 40.59%, Specialist = 40.59%	NR	amount of remaining tooth structure	NR
<b>Iqbal et al., 2021</b>	NR	NR	both amalgam and composite as a	margins and size of the cavity, patient preference, ease of cavity preparation, experience level, safety, pregnancy-related concerns	NR
<b>AlZain et al., 2019</b>	Cast post-and-core and crown (74.6%)	NR	only amalgam restoration (39.9%), amalgam or tooth-colored restoration and crown (30.9%),	amount of remaining tooth structure	NR
<b>Alenzi et al., 2018</b>	PfP (84.1%): Fiber-reinforced composite posts (79.9%), MP (15.9%)	Dual polymerized adhesive RC (34.1%) and Self-adhesive RC (34.1%) Posts were placed primarily with zinc phosphate cement (51%), followed by GIC (38%).	composite resin (51%) GIC (26%), Amalgam (0.5%)	remaining tooth structure (77.4%), ease of use (7.3%), fewer visits (3.7%), cost (1.8%), aesthetic purposes (0.6%), tooth location (anterior or posterior) (2.4%), canal width (2.4%) conservative preparation for using composite (55.9%). Aesthetics for limitation of using amalgam (52%).	NR
<b>Alsughair et al., 2018</b>	NR	NR	composite resin		NR
<b>Alasmari et al., 2016</b>	PfP	NR	tooth-colored composite >50% of the natural tooth structure remained after endodontic treatment. Tooth-colored composite & prefabricated post with tooth-colored crown, both equally preferred for <50% of the tooth structure was remaining	remaining tooth structure	NR

<b>Akbar et al., 2015</b>	PfP (25.4%): MP (43.1%), Fibre post 63(41.1%)	GI (76.4%), RC (13.7%), ZP (7.8%)	composite resin (61%) amalgam (23%)	NR	crown fracture (45%)
<b>Habib et al., 2014</b>	PfP (53%)	GI (48%), Resin cement (22%), ZP (21%), Resin modified GIC (10%), Poly carboxylate (3%)	composite (57%), amalgam (19%), Cast core (16%), GI (13%)	NR	endodontic failure (47%)

*Prefabricated Post (PfP); Metal Post (MP); Glass Ionomer (GI); Glass Ionomer cement (GIC); Cast Post (CP); Zinc Phosphate (ZP); General Practitioners (GP); Resin Cement (RC); Not reported (NR).*

## Discussion

Dentists are confronted with a continuously growing number of various materials for post-endodontic restoration and with an increasing occurrence of ETT in need of treatment. The study results from Saudi Arabia showed that dentists favored using prefabricated posts, such as fiber and metal-based posts, to restore ETTs and resin-based cementing agents. The preferred material for the core foundation built for ETT by regular dentists, specialists, and students is regarded as composite. The findings showed that various variables could affect dentists' preferences for and decisions about restorative procedures. While there has been tremendous progress throughout the entire field of dental materials over the past century, this article will highlight pivotal advances in dental amalgams, dental composites, and cement, because these likely have had the greatest impact on the profession and the oral health of literally billions of dental patients. Based on the studies published in Saudi Arabia, the preferred post is the prefabricated post, and the restorative core foundation material for general dentists, specialists, and students is regarded as composite. The present systematic review findings can be used to learn more about beliefs, ETT treatment methods, choices of restorative materials, and factors affecting the decision and reasons associated with the failure of ETT.

### Choosing of ETT restoration

The best technique to restore an ETT treatment is still a contentious issue that sparks a lively discussion. Dentists must retain as much healthy hard tissue as they can since losing the tooth's coronal hard tissue hinders the tooth's biochemical durability and general health. Additionally, the restoration of choice must be appropriate to minimize the risk of the crown and/or root fracture (20, 21), provide an adequate coronal seal to prevent future recontamination of sealed roots, be able to replace the destroyed dental tissue, and restore normal coronal morphology and function. To satisfy the requirements

for a coronal restoration, several things must be taken into accounts, such as functional requirements, use of posts, amount of remaining coronal structure, aesthetic preference, and cost of value.

The preferences of the students for posterior restorative materials and the many factors influencing the selection of composite and amalgam for restoration were analysed by Pani *et al.* (10) and Iqbal *et al.* (13). In the study by Pani *et al.* (10), the students in the private school assigned higher scores to composites that pertained to patient perception, ease of use, and cost of the material and cavity preparation. Students said that the patient's preferences had a significant impact on the composite material selection. Most students were not swayed by safety considerations when choosing the material. When it came to pregnancy-related safety issues, there was a noticeable difference among the students because neither amalgam nor composite had any bearing on the material choice, according to Iqbal *et al.* (13)

When selecting a restoration, it is important to take into account the position and positioning of the tooth inside the arch since occlusal pressures are unevenly distributed throughout the arch, with the anterior and posterior portions exerting the least and most force, respectively. According to the study participants in Zahran *et al.*'s (9) study, which was more focused on the tooth position such as anterior, premolar, or molar, posts were frequently placed in anterior teeth (56.5%), premolar teeth (84.1%), and molar teeth (64.5%). Non-metallic posts and cast posts and core were the preferred options for anteriors and molars, and responses were equally divided between non-metallic posts and cast posts and core for premolars (9).

The kind of restoration that is required depends on fracture resistance and remaining tooth structure majorly, which is influenced by the amount of residual tooth structure. For instance, a tooth with substantial coronal structure loss could need a post and core and a full-coverage crown to keep the permanent restoration in place, whereas a tooth with moderate coronal structure

loss might only need a direct composite restoration to close the access cavity. Al zain *et al.*, (14) assessed ET at three different levels (percentages) of sound tooth structure (> 50%, = 50%, and 50%). While 30.9% of respondents wanted to use a restoration followed by a crown at 50% of the remaining tooth, 39.9% of respondents preferred to use an amalgam restoration at > 50% of the remaining tooth. In a review paper, it has been stated that direct composite resin or an amalgam restoration can be used to restore the endodontic access, with a very good prognosis. Similar findings were reported as per Alenzi *et al.* (15) stating that the essential factor in deciding between fiber posts and custom-made posts is the amount of preserved tooth structure. The demand for custom-made posts and cores, which enable closer adaptation to the post space than prefabricated posts, increases with tooth material loss, which is one plausible reason for this observation. Among the participants of the Shetty *et al.* (12) study, almost over 30% of general practitioners (37.12%) and specialists (32.17%) claimed restoration of ETT was based on the residual tooth structure. According to Alasmari *et al.* (17), tooth-colored composite restoration was preferred when less than half of a tooth structure is present in an anterior or posterior restoration. Both general dental surgeons and specialists favored tooth-colored composite and tooth-colored crowns as their preferred materials, with no discernible differences. The necessity to meet the rising demands of patients and dentists for highly aesthetic and biocompatible restorations can be used to explain the movement among dentists in the included study toward tooth-colored composite restorations.

Regarding cost effectiveness, the preference for glass fiber posts can also be explained by the increased long-term expenses of cast metal posts, their negligible increase in effectiveness, and their poor appearance. However, some still perceive the glass fiber posts and cast metal posts as cost-effective because they successfully hold teeth in place for extended periods (22). A composite resin restoration used to be less expensive than an amalgam restoration in the past, but new advancements in composite resins and rising silver prices have made this distinction no longer hold (23-25).

Despite all other factors, when faced with the same clinical issue, different dentists will arrive at different clinical decisions. These professional discrepancies are well acknowledged and are referred to as "normal variations" in dentists' clinical judgments. Respondent experience level and qualification level have a

significant impact on ETT technique choice and restorative material preference. However, in Alobaidi *et al.* (11) study, no significant difference was achieved when compared based on qualification. Additionally, the less experienced dentists showed better knowledge and practice as compared to the more experienced ones. In their survey, the material of choice to treat endodontically treated teeth when more than 50% of the crown is remaining is composite: 62% Amalgam: 22% GIC: 16% and a respondent with more than 10 years of experience answered that composite: 47% Amalgam: 39% GIC: 14%. Also in Shetty *et al.* (12) study, no significant differences were noted in the preferences of post-material between general practitioners and consultants or specialists. However, in the case of choosing a cementing agent, all the specialists preferred resin cementing agents only.

### ***Restorative Material of Choice***

#### ***Post Type***

Posts made of glass fiber, cast metal, carbon fiber, and prefabricated metal all have unique mechanical characteristics. The use of prefabricated fiber posts was more common compared to metal posts in this review. The same trend has been observed in studies from the UK and Sweden (26, 27). However, in one study, the choice of prefabricated and cast posts was almost equally preferred by the participating dentists and the specialists (9). Over half of the respondents polled preferred the use of fiber-reinforced post types for restoration in Alobaidi *et al.* (11), study. In the most recent studies that have been used for this review, prefabricated glass fiber posts have been extensively used. A systematic review by Giroto *et al.* (6) showed that prefabricated posts and cast metal posts were the two most often reported choices for the type of posts utilized. This is in line with the present systematic review of Saudi Arabian studies. In surveys released prior to 2010, cast metal post type types were more frequently mentioned, although prefabricated posts—both metal and glass fiber ones—were mentioned in the most recent studies (6).

#### ***Composite resins***

The majority of the articles that were reviewed discussed dentists' preferences for the cementing agent employed for the posts. The preferred cementing agents were those based on resin, followed by glass ionomer cement, zinc phosphate, and resin-modified cement. Recent research has seen an increase in the use of resin-based cementing agents, whereas earlier studies have seen an increase in the use of zinc phosphate cement. Most of the research

employed resin-based luting agents since they are widely recommended to lute prefabricated posts, including self-adhesive resin and traditional dual-polymerized adhesive resin. Over the past ten years, composite resins have gained popularity among dentists, and their clinical longevity has risen as a result of improvements made to their quality. Due to their chemical affinity for tooth structure and resemblance to it in terms of hardness and fracture toughness, resin-based composite core materials are more widely used, with the benefit that preparation can be done after curing (28). Modern composite resins are used in numerous restoration procedures for both anterior and posterior teeth (29). Recently published studies in this review reported that resin-based cementing agents were preferred by the respondents, while two included studies (18, 19) published before 2016 reported that GI was the preferred cementing agent compared to resin cement.

A comprehensive nationwide survey regarding treatment strategies for ETT, which covered the North, South, West, East, and Center regions of Saudi Arabia, conducted by Alenzi *et al.* (15), concluded that most dentists studied did not contemplate that ETT should be given a post. Most responders (93.3%) favored resin-based materials for the type of core build-up material frequently utilized with prefabricated posts.

Composite resin (57%) was preferred for the core foundation, followed by amalgam (19%) among the participants (19%). The use of composite resin as a core and extra coronal restoration for restoring ETT is common among participants in Zahran *et al.*'s (9) and Alenzi *et al.*'s (15) survey studies. The tooth-colored composite was the material of choice among dentists when more than half of the natural tooth structure remained after endodontic treatment. If less than 50% of the tooth structure remained, both tooth-colored composite and prefabricated post with tooth-colored crowns were equally preferred. As per Alsmari *et al.* (17) both general dental surgeons and specialists agreed that tooth-colored composite was the best restorative material for teeth that had undergone endodontic treatment and still had more than 50% of their original tooth structure. However, doctors equally favored tooth-colored composite and prefabricated posts with tooth-colored crowns when less than 50% of the tooth structure is still present.

In an included study, this review compared composite and amalgam restorative materials and reported that the margins of the restoration and isolation were also essential considerations for students when considering

composite restorations since they are a crucial factor for composite restoration success. It was also observed that due to the simplicity of handling the material and preparing cavities for it, students had a stronger preference for composite materials (13). Although this pattern is consistent with research from the United Kingdom and Irish dental schools (30). It is alarming that students are growing less at ease with the preparation of amalgam cavities. The graduates are obliged to employ both amalgam and composite materials when they go out to work in the community. However, Zahran *et al.* (9) found composite resin as a core build-up material in anterior teeth (92%), premolars (85%), and molars (78%), respectively. Pani *et al.* (10), found that composite resin was the material preferred by a majority of the students regardless of the type of school, such as government and private dental schools, for posterior dental restoration. Students in both colleges were likely to give higher scores for composite than amalgam. However, a majority of the respondents listed micro-leakage as the greatest drawback of composites.

### **Amalgam**

Amalgam is the most versatile dental restorative material. It accounts for almost 75% of all restorative materials used by dentists worldwide. Prior to its fall five decades ago, amalgam was for a while the most often utilized restorative material for posterior teeth. In Saudi Arabia, dental amalgam is still the most often utilized restorative material. Amalgam use has declined and even ceased in certain developed countries. In Saudi Arabia, there are no regulations to control the use of dental amalgams. However, guidelines by the ministry of health on the use of separators in dental chairs, proper mercury hygiene, and disposal of amalgam scrap are enforced. Furthermore, there is a marked movement in dental academic institutions toward increased emphasis on training dental students to use mercury-free alternatives guided by the Minamata Convention (31). That is evident in our included studies with respondents as dental students. Most students preferred resin-based restorative materials over amalgam. Due to the fact that amalgam requires more tooth preparation than other restorative materials to be retained, it goes against the conservative dentistry philosophy (3). However, amalgam is still the material of choice for treatment in the government at >50% of the remaining teeth, 39.9% of the respondents preferred to use an amalgam restoration (14). When asked to list the main drawbacks of amalgam, most of the respondents answered lack of aesthetics for amalgam (10).

Regarding the most frequent failure of restored endodontically treated teeth, 47% of the participants thought the endodontic failure to be the most common reason. The responses to crown fracture, root fracture, and loss of retention were 31%, 15%, and 9%, respectively, in Habib *et al.*'s (19) study. Microorganisms can enter the root canal in inadequately restored coronal restorations and root canal fillings. This led to the failure of the restoration. Akbar *et al.* (18) reported that crown fracture was the most frequent cause of the failure of ETT.

Regarding limitation of the study, the objectives of the investigations varied, making it challenging to compare them and consider the various consequences about the recovery of ETTs. The majority of studies were deemed "Unclear" due to missing information in the filled-out questionnaires, showing that it was possible to determine the methods used to handle missing data or the effect of this on the outcomes. If there were a large number of missing data points from unanswered questions, this could add bias to the original data.

## Conclusion

The study results from Saudi Arabian data showed that dentists favored using prefabricated posts, such as fiber and metal-based posts, to restore ETTs and resin-based cementing agents. The preferred material for the core foundation built for ETT by regular dentists, specialists, and students is regarded as composite. The amount of coronal tooth structure that is still present is crucial when choosing the post type and restorative material. Guidelines that attempt to limit variation and ensure the quality of care for every patient need to be developed. It can reduce the result of variations in dentists' clinical judgments and their effects.

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There is no conflict of interest

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### *Ethical consideration*

Non applicable

### *Data availability*

Data that support the findings of this study are embedded within the manuscript.

## *Author contribution*

All authors contributed to conceptualizing, data drafting, collection and final writing of the manuscript.

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