

# Why, when, and how general practitioners restore endodontically treated teeth: a representative survey in Germany

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## Abstract

**Objective** The purpose of this study was to assess current opinions, applied techniques, and materials for the restoration of endodontically treated teeth (ETT) in a nationwide survey in Germany.

**Material and methods** Completed questionnaires from 1,648 dentists were returned (response rate 63 %).

**Results** In general, posts were reported to be used more frequently (51 %) for indirect restorations than for direct restorations (21 %). Dentists restored anterior teeth (65 %) more frequently with direct restorations than posterior teeth (48 %). Compared to an earlier survey, fewer dentists stated that post-treatment stabilizes the remaining tooth structure. The ferrule effect as a key success factor was held by the vast majority of dentists (88 %). A trend towards adhesive techniques both for post placement and core build-up was observed. Composite resins (49 %) were reported to be used twice as much as zinc phosphate cement (24 %) for the luting of posts; composite resins were the core build-up material of choice (75 %). Amalgam was rarely used (0.2 %). Irrespective of the final

restoration, fiber posts were the most popular post material (46 % for telescopic crowns vs. 69 % for single crowns).

**Conclusion** Adhesive composite core build-ups with and without fiber posts were the predominant treatment approach to restore ETT in Germany. There was widespread agreement with the ferrule effect as a key restorative success factor for indirect restorations.

**Clinical significance** Today, it is general accepted that ferrule preparation is key. Glass-fiber posts appear to be most popular. Still different systems are used depending on type of final restoration, while the reasons to do so remain unclear.

**Keywords** Post-and-core technique · Dowel · Root · Root-treated teeth · Reconstruction

## Introduction

Recently, a long-term randomized controlled study was published, documenting that post-endodontic restoration was clinically reliable, irrespective of the rigidity of the post-material used [1]. The relatively new types of so-called dentine-like glass-fiber posts do work when combined with composite resin core build-ups. The presence of a minimum of 1.5–2.0 mm wide ferrule preparation is the key success factor [2] as well as the amount of hard tissue loss [3–9]. Furthermore, the survival of endodontically treated teeth (ETT) is influenced by a variety of different parameters, which can only be partly controlled by the dentist, such as the number of adjacent teeth [10, 11], occlusal contacts [12], position of the tooth in the dental arch [13, 14], apical status [15], collagen degradation [16], intermolecular cross-linking of the root dentine [17], remaining dentine wall thickness [14, 18–20], and type of final restoration [9, 11, 13, 21–23].

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It is generally accepted that the purpose of post placement is to retain a core foundation [17, 24] and not to reinforce an ETT [5, 25–27]. Despite their disadvantages concerning the integrity of the roots, screw-type posts were reported to be widely used [28–35]. Cast post-and-cores and prefabricated posts with composite resin foundations were found to result in comparable loads-to-fracture [36]. Dentists are confronted with a continuously growing number of different materials for post-endodontic restoration and with an increasing number of ETT needed to be restored [37]. However, the scientific literature provides numerous, mostly material-oriented, non-comparable, and thus eventually confusing *in vitro* studies [38]. Hence, it is not surprising that the manner in which post-endodontic restorative care is performed does not always reflect the best available scientific evidence [39], but is rather influenced by geographic location, age, and speciality status [40]. Several surveys have been performed in various countries to elucidate which treatment concepts and materials for endodontic and post-endodontic restoration are favored by dental practitioners [32–35, 39–43]. The present survey was conducted to update a previously performed study [44] of similar content regarding current use of different post-and-core techniques to restore ETT by German dentists.

## Material and methods

### Recruitment of the participants

The survey was performed in the same manner as described for a previous nationwide survey organized by the authors [43]. The participating dental practitioners were selected randomly within five regions defined on the basis of postcode areas (two digits) in Germany. A commercially available database of German dental practitioners was used for the selection. Dental students exclusively hired and briefed to conduct this survey within a period of 4 months visited the selected dentists. After verbally explaining the objective of this survey, each participant received a questionnaire and a product sample of Smart Dentin Replacement (SDR, DENTSPLY DETREY, Konstanz, Germany) as incentive and in order to rate its suitability for directly restoring ETT. Besides this, the participants received no further compensation.

The participants were asked to return the questionnaire by fax. In total, 2,626 of the dentists initially agreed to participate. A total of 1,648 dentists returned the completed questionnaire, resulting in a response rate of 63 %. Non-responders were not reminded due to the anonymous character of this survey.

### Questionnaire

A slightly modified, shortened version of the questionnaire previously used for a survey by the present research group

in 2006 [44] was used. A cover letter stated the instructions, rationale, and purpose of this survey. The questionnaire contained 13 multiple-choice questions dealing in the first section with the treatment concept for ETT, and in the second section with questions related to materials and methods used for the treatment including questions regarding the specific use of flowable composites adopted from an earlier questionnaire [43]. Regarding the frequency of post placement, “seldom” was defined as an assumed need for post placement in up to 30 % of ETT, “frequently” for between 30 to 70 % of ETT, and “usually” for more than 70 % of all ETT a cast restoration was planned for.

The following questions were posed (translation of the original German):

- “What percent of ETT do you insert a post for (A) direct restorations and (B) laboratory restorations?”
- “Are you of the opinion that a post does strengthen an ETT and reduces the probability of fracture?” Dentists could choose between “yes, in every case,” “yes, but only when I cement the post adhesively,” “yes, but only when I place the post conventionally,” “no,” or “other.”
- “Are you of the opinion that envelopment of the ETT within sound dentine by a crown restoration (ferrule, ferrule effect) does increase the fracture resistance of ETT?” Dentists were able to choose between “yes,” “no,” or “don’t know.”
- “Which type of cement do you use most frequently for endodontic post cementation?” Dentists could choose between “zinc phosphate cement,” “polycarboxylate cement,” “glass ionomer cement,” “composite resin cement,” or “other.”
- “How frequently do you observe failures in the treatment of ETT?” Dentists could give the frequency of failures in percent for “loss of post retention,” “root fracture,” “crown fracture,” “endodontic problems,” or “other.”
- “Which type of post do you use most frequently for the build-up of ETT, when the following restorations are planned?” Dentists could choose between “glass-fiber posts,” “metal posts (active as prefabricated posts),” “metal posts (passive as screws),” “cast post-and-cores,” and “other” depending on the type of reconstruction planned such as “direct restorations,” “single crowns,” “fixed partial dentures,” and “telescopic crown restorations as part of combined fixed-removable partial denture.”
- “Which core build-up material do you use most frequently when a laboratory restoration is planned?” Dentists could choose between “amalgam,” “composite resin,” “glass-ionomer,” or “composite-modified resins (compomers).”
- “Do you restore ETT with direct composite resin restoration?” Dentists could choose between “yes” and a number in percent for anterior and posterior teeth, respectively, or “no” or “only in very few cases.”

- “Which kind of adhesive do you use when restoring ETT with direct composite restorations?” Dentists could choose between “etch/rinse” and “self-etch.”
- “Do you preferably use a flowable composite when restoring ETT with direct composite restorations?” The participants could choose between “yes” or “no.”
- “Why do you use a flowable composite when restoring ETT with direct composite restorations?” This question was only asked those participants that stated they used flowables. They could choose from the following answers, and multiple answers were possible: “to avoid voids,” “for better adaptation to the cavity wall,” “as stress breaker,” “to save time,” “for a bacteria-tight seal,” and “other reasons,” which had to be named.
- “Why do you not use a flowable composite when restoring ETT with direct composite restorations?” This question was only asked to those participants that stated they did not use flowables. They could choose from the following answers, and multiple answers were possible: “because flowables show a higher shrinkage stress leading to leakage,” “because of their lower mechanical strength,” “because they cannot be sculpted,” “because it doesn’t give me a clinical advantage,” and “other reasons,” which had to be named.
- “Please rate the test material in comparison with your current filling material for restoring ETT with direct composite restorations in terms of time saving, simplicity of procedure, overall handling, creation of good proximal contacts, and internal adaptation.” Each aspect had to be rated in comparison to the technique currently used by the dentist. The participant could choose between “better,” “slightly better,” “slightly worse,” or “worse.”

**Statistics**

The returned questionnaires were anonymized, and the data was analyzed using descriptive statistics (software package SPSS 19.0, SPSS Inc. Chicago, ILL, USA). Frequency distributions (for treatment philosophy including standard deviation) were used for descriptive statistical representation of the results.

**Results**

A total of 1,648 questionnaires were completed. The data focusing on the treatment concept is presented in Table 1. According to this data, 51 % of all dentists stated that they place a post frequently or always when an indirect restoration is planned, while 39 % stated to do this seldom (Table 1). In the case of a direct restoration being used as a permanent

**Table 1** Data focusing on treatment concept

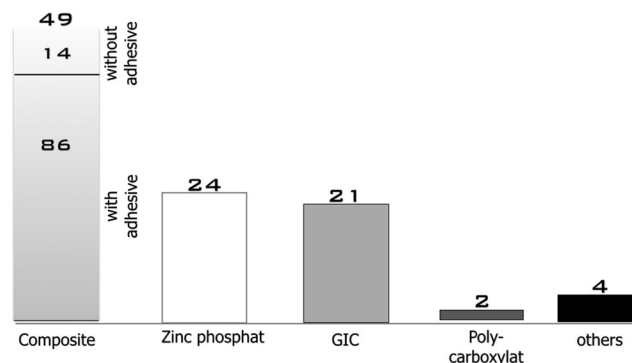
How often do you place a post in directly restored ETT?	
Seldom	79 %
Frequently	11 %
Always	10 %
How often do you place a post in laboratory restored ETT?	
Seldom	39 %
Frequently	28 %
Always	33 %
Do you believe that a post reinforces an ETT and reduces the fracture probability?	
Yes, definitely	27 %
Yes, if adhesively luted	30 %
Yes, if conventionally luted	1 %
No	30 %
Other	12 %
Do you believe that reducing the level of the finishing line below the core foundation following post cementation increases the fracture resistance?	
Yes	88 %
No	7 %
Not specified	5 %

ETT endodontically treated teeth

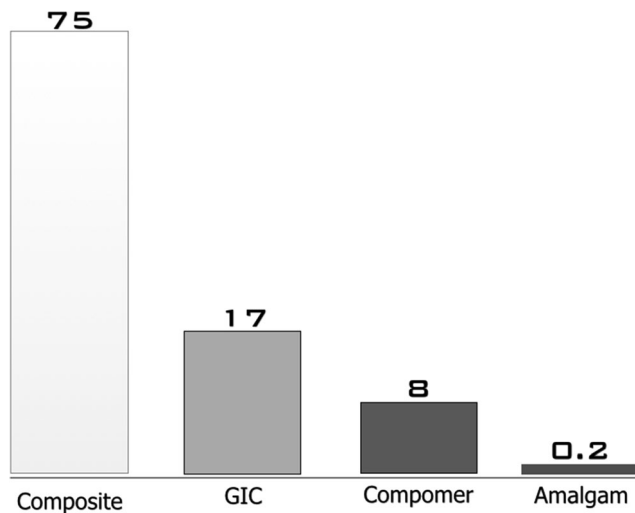
restoration for ETT, just 21 % of the participants would place a post frequently or always.

More than half of all respondents (57 %) expected reinforcement for ETT and a decrease of fracture probability when posts are used. Twenty-seven percent expressed the opinion that reinforcement is achieved independently of the type of cementation, while 30 % believed that an adhesive approach is necessary for reinforcement. Only 1 % of the participants still claimed to believe in a purely conventional, non-adhesive approach. Thirty percent agreed with the statement that no reinforcement can be expected from a post.

Most dentists (88 %) claimed to understand that an embracement of healthy tooth structure (dentine) apical to the finishing line, i.e., the so-called ferrule, increases fracture resistance. Seven percent stated to not believe in this concept.



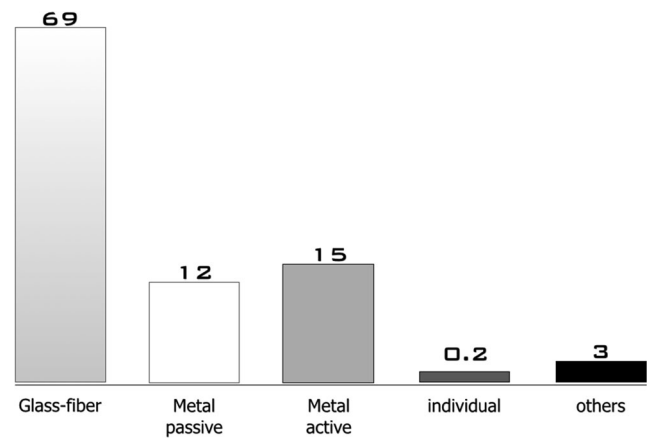
**Fig. 1** Which cement you prefer for post cementation



**Fig. 2** Which is your favorite core build-up material for post-restoration

Resin composite cements (49 %) were used most frequently, followed by zinc phosphate (24 %), glass-ionomer (GIC) (21 %), polycarboxylate (2 %), and other cements (4 %) to retain endodontic posts. Eighty-six percent of all dentists claimed to prefer composite resin cements with the help of adhesives. In this context, 31 % stated to use self-etch materials, while 45 % stated to apply the classic etch-and-rinse approach. Fourteen percent claimed to lute posts using self-adhesive cements without an additional adhesive (Fig. 1).

When planning for a laboratory restoration, most of the participants (75 %) stated to use resin composites as core build-up material (Fig. 2). Resin composites as final direct restoration for ETT were used by 85.3 % of the dentists in 65 % (SD 44 %) of their cases when treating anterior teeth and in 48 % (SD 30 %) of their cases when treating posterior teeth. In the case of resin composites being used as a permanent direct restoration, the additional use of flowable composite resin material was claimed by 44 % of the dentists, while 14 % did not. For those cases in which flowables were used, the reasons given were “better adaptation” (84 %), “avoiding heterogeneities” (78 %), “avoiding bacterial leakage” (44 %), “stress breaker” (42 %), and to “save time” (17 %). If dentists answered that they did not use flowables, the reasons given were “lower mechanical strength” (43 %), “no clinical advantage” (40 %), “not able to be sculpted” (36 %),



**Fig. 3** Which post type do you used most frequently for post-and-core build-up, when direct restorations are planned

“inappropriate seal” (26 %), and “others” (15 %). In this context, the use of SDR [43], being a bulk-fill flowable with low shrinkage stress, was judged as “convincing” or “very convincing” by 77 % of the respondents. The reasons provided were a subjectively estimated easier application (88 %), a better adaptation of the material (86 %), and time-saving (84 %). Glass-ionomers (GI) and resin-modified GI were used in 17 and 8 %, respectively. Amalgam was very rarely used (0.2 %).

The preference regarding the post type was stratified by “type of final restoration” (Table 2). Glass-fiber posts were most widely used for direct restorations (69 %), while active metallic posts, i.e., endodontic screws, followed at a reduced frequency (15 %) (Fig. 3). When single crowns were planned, slightly fewer fiber posts (58 %) were placed in favor of endodontic screws (16 %) (Fig. 4). For fixed partial dentures (FPD), glass-fiber posts were preferred by half of all dentists. Metallic active (17 %) and passive posts (17 %), i.e., prefabricated posts combined with composite cores, were inserted slightly more often than individually cast post-and-cores (16 %) (Fig. 5). When telescopic crowns were combined with a removable denture, glass-fiber posts remained most popular (46 %), but individual cast post-and-cores were preferred by 20 % of the respondents (Fig. 6).

Reported reasons for the failure of post-endodontic restoration were crown fracture and failure of the endodontic treatment with 13 % of the respondents each. Loss of post retention

**Table 2** The preference regarding post type

Final restoration	Glass-fiber post [%]	Passive prefabricated metallic [%]	Active prefabricated metallic post [%]	Cast post-and-core [%]	Others [%]
Direct (chair side)	69	12	15	0.2	3
Single crown	58	14	16	11	1
Fixed partial denture	49	17	17	16	1
c-FRPD	46	15	17	20	1

c-FRPD combined fixed-removable partial denture

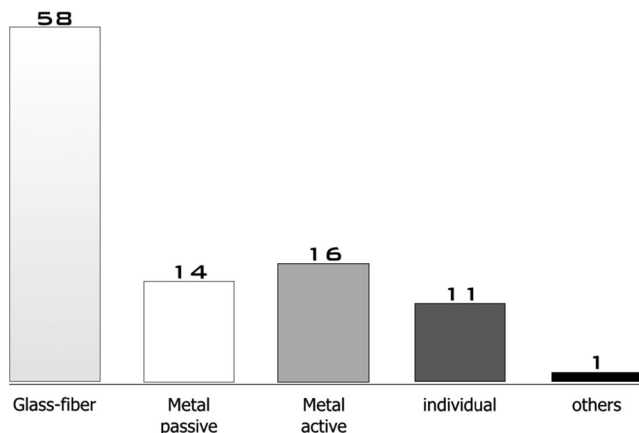
was mentioned as the third most frequent problem by 11 % of the dentists followed by root fracture (7 %) and other reasons (10 %).

### Discussion

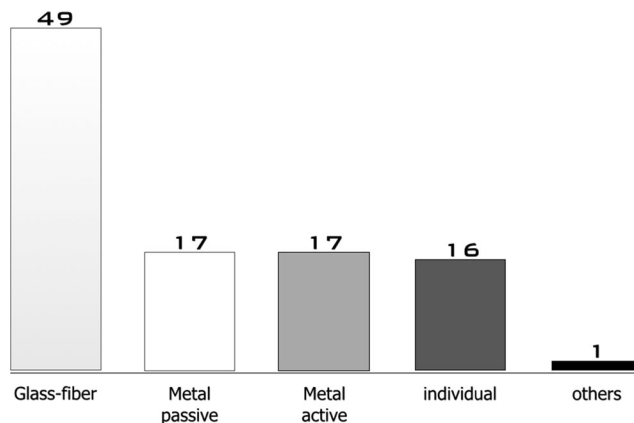
A nationwide representative survey was conducted to update the recent treatment philosophy and materials used in post-endodontic restoration, since the last study of this kind was performed almost a decade ago. We found that glass-fiber posts were the preferred option to be inserted in more than half of the abutment teeth when laboratory restorations are planned. The type of final restoration influenced the type of post chosen. The rationale behind this choice remains unknown. Direct restorations were more frequently used in front teeth without post support (~80 % of the cases). Adhesive techniques by means of composite resin are popular both for post cementation and core build-up. The majority of dentists claimed to believe in the reinforcement effect of an endodontic post. Nine out of ten respondents expressed their opinion that the ferrule and its effect reduce the risk of fracture of ETT.

The present survey was performed to update the information about current treatment approaches and materials used in post-endodontic restoration in Germany. The questionnaire of this survey is a slightly altered version of the one published in 2006 [44]. The return rate of the questionnaire was 63 %. This is in line with response rates reported in other studies, which ranged from 25 to 70 % [32, 33, 41]. Unfortunately, the anonymous nature of the survey did not allow for a reminder mechanism.

The majority of dentists (58 %) agreed with the statement that endodontic posts reinforce ETT. In comparable studies among general practitioners in Sweden, the UK, and the USA, 29, 25, and 59 %, respectively, were of the same opinion [34, 35, 40]. In comparison to the survey performed earlier, more than double the respondents in the present survey agreed



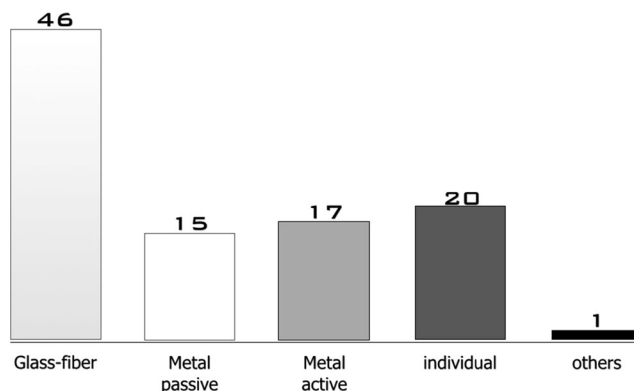
**Fig. 4** Which post type do you used most frequently for post-and-core build-up, when single crown restoration are planned



**Fig. 5** Which post type do you used most frequently for post-and-core build-up, when FPDs are planned

that a reinforcing effect is to be expected when post placement is performed adhesively, while half of those still agreed that a reinforcing effect would be expected in any case. However, a difference was observed between direct and laboratory restorations: in direct (composite resin) restorations, respondents stated that posts were seldom (80 %) inserted, while in laboratory restorations, only one third would place a post and it remains unknown what the occasion may be. One may therefore conclude that dentists are aware that a post is not needed for every ETT, but they rather place a post for more “safety,” since laboratory restorations are more costly and failure would cause more economic problems. This is contrary to the current state of evidence-based knowledge, which maintains that a post does not result in a reinforcement of the root or tooth, but supports the core build-up [5, 27].

The number of respondents who reported to perceive a reinforcement effect by using the ferrule effect was 88 %, which is again higher compared to the earlier study (72 %). The trend appears to be in increasing agreement with the scientific literature. As recently shown in a randomized controlled trial by the present research group, the ferrule effect—and not post material—is key to avoiding clinical failures [1, 2, 45–50].



**Fig. 6** Which post type do you used most frequently for post-and-core build-up, when telescopic are planned



At the time of writing this report, there is a preference for prefabricated glass-fiber post systems. Thus, in the last decade, tremendous changes have occurred in the material of choice. This is surprising, since glass-fiber-based endodontic posts are relatively new materials, having been introduced around the year 2000. Interestingly, its use was distinguished between the types of planned final restoration. The more complex and thus costly a restoration is, the more established the choice, i.e., for the most complex prosthodontic restoration of a combined fixed-removable restoration (c-FRPD), the amount of cast post-and-core increased from 11 (for single crowns) to 20 % (c-FRPD). The findings differ clearly from data gathered from Sweden and the UK [34, 35] where the cast post-and-cores were the treatment of choice. A positive finding of the present survey is that there is a significant reduction in the reported use of screw posts, which are generally known to introduce stress into tooth hard tissue. Therefore, it is not surprising that root fractures, formerly observed as the third most common cause for failure (26 %), are in the present survey mentioned with an incidence of only 7 % (less than crown fracture, endodontic problems, and loss of post retention). The question remains which decision criteria led to the preferred use of a selected post system. In the scientific literature, no unequivocal final restoration-related evidence-based recommendations exist, may be because the choice of the restoration also depends on the preferences of the dentist and the patient [51].

In contrast to results found in two regions of the UK [32, 34] and the USA [40], where amalgam is popular, amalgam is now rarely used for core foundation procedures in Germany (0.2 %). This might be due to the fact that within the German population amalgam is still considered to cause health threats such as mercury toxicity. The majority of German dentists uses composite resin (75 %), followed by GI and resin-modified GI (25 % overall). With the exception of GI, these results are in agreement with observations made in the USA [40]. While composite resin and amalgam are recommended as core materials, GI was found to be unsuitable, especially for large defects without hard tissue support [52–54]. Less frequent use of GI and RMGI in Germany (~25 %) compared to earlier data (40 %) might have also contributed to a reduced incidence of failure of the post-endodontic restoration.

Compared to the earlier survey, the treatments performed by German dentists are in general closer to current treatment recommendations published in 2006 [44]. Significant changes in the choice of materials, in favor of adhesive approaches, were found. In particular, the rapid increase in the reported use of glass-fiber posts is astonishing. However, it still remains unclear what criteria determine the specific choice of post-endodontic restoration material, in particular with regard to tooth type and type of prosthodontic reconstruction. This finding reflects the current scientific dilemma with in-part equivocal recommendations and missing long-term clinical data.

## Conclusions

Within the limitations of the present study, the following conclusions were drawn:

Glass-fiber posts were the most frequently used restoration material by surveyed dentists in Germany, independent of the prosthodontic restoration planned. Composite resin cores were preferred by three quarters of the dentists. Half of the dentists performed adhesive post placement. There was widely held agreement with the importance of the ferrule and its effect. The majority of dentists reported they would not place a post for direct restoration (single-tooth), while in abutment teeth for laboratory restoration, only one third claimed they would do so.

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**Conflict of interest** The authors deny any conflicts of interest.

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