

MAGDALENA KON
NICOLA U. ZITZMANN
ROLAND WEIGER
GABRIEL KRAS TL

Clinic for Periodontology,
Endodontology and Cariology,
University of Basel, Switzerland

Correspondence

Dr. Gabriel Krastl
Department of Periodontology,
Endodontology and Cariology
University of Basel
Hebelstrasse 3
CH-4056 Basel
Switzerland
E-mail: gabriel.krastl@unibas.ch
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Postendodontic Restoration: A Survey Among Dentists in Switzerland

Key words: postendodontic restoration, root canal post, survey

Summary The purpose of this study was to evaluate the present opinions and the knowledge of Swiss general dentists about current strategies to restore endodontically treated teeth.

Between 2009 and 2011, a 17-item questionnaire was given to 95 general dentists at the beginning of continuing education courses related to this topic.

The majority of dentists indicated that they restore more than 30 endodontically treated teeth per year. The decision for placing an intracanal post was mainly based on the amount of remaining tooth substance and the type of tooth (anterior tooth, premolar, molar, or abutment for fixed dental prostheses). Most re-

spondents strove for a retention depth of at least two-thirds of the root length and a form-congruent fit between post and post space preparation. In terms of post type, metallic posts were predominantly used, while an increasing application of glass-fiber posts was registered. Regardless of the type of post, composite cements were the most commonly used luting materials.

The prevailing strategies for the restoration of endodontically treated teeth are in part in accordance with the current literature. Disagreements with the literature are related to the post length, the desired post fit and the fact that metal screw posts are apparently still in use.

Introduction

Numerous studies have confirmed that the prognosis of an endodontically treated tooth does not depend exclusively on the endodontic procedures per se, but is essentially influenced by the postendodontic restoration (LYNCH ET AL. 2004, RAY & TROPE 1995, TRONSTAD ET AL. 2000). The latter is complex and dependent upon several different factors, e.g., substance loss, tooth type, the decision for or against intracanal anchorage, choice of post and core build-up material, length and precision of fit of the endodontic post, luting medium, and type of supraconstruction (AL-OMIRI ET AL. 2010, BITTER & KIELBASSA 2007, SCHWARTZ & ROBBINS 2004).

Over the past 20 years, numerous in vitro and in vivo studies have been published in the field of postendodontic restoration. On the one hand, the use of adhesive techniques in the root canal has enabled intracanal anchorage (GORACCI & FERRARI 2011); on the other hand, current recommendations suggest a more conservative use of endodontic posts (DIETSCHI ET AL. 2007, 2008, KRAS TL ET AL. 2008). However, it is difficult to predict the extent to and speed with which the latest scientific knowledge will be established in daily routine of the private practitioner (MOHL & OHRBACH 1992).

A few questionnaire-based studies have been published on the knowledge and preferences of dentists in terms of restoring endodontically treated teeth. Such data exist for Great Britain (HUSSEY & KILLOUGH 1995), Sweden (ECKERBOM & MAGNUSSON 2001), the USA (MORGANO ET AL. 1994), Germany (NAUMANN ET AL. 2006A), and Switzerland (TINNER ET AL. 2001). Given the fact that much new knowledge has been gained in the last decade, it makes sense to collect current data for Switzerland.

The purpose of the present questionnaire-based study was to evaluate the predominant opinion and knowledge of Swiss dentists in terms of current strategies for restoring endodontically treated teeth.

Materials and Methods

To collect data, a questionnaire in German was constructed. Between 2009 and 2011, the questionnaire was distributed to 95 dentists attending continuing education seminars on "Post-endodontic Restoration" and collected before the start of the given seminar.

In the first part, general personal information on age, sex, professional work experience, and practice location (urban vs. rural) was requested. The second part of the questionnaire

contained twelve items and focussed on the treatment philosophy of postendodontic restoration and the materials and methods used. Questions on frequency were answered on a 5-point scale: very often (>90%), often (ca. 75%), occasionally (ca. 50%), rarely (ca. 25%) and never (0%). The questions covered the topics explained below.

Frequency of use of intracanal posts

The study participants reported the annual number of teeth in which they placed postendodontic restorations. In addition, the frequency of posts used depending on tooth type and lesion geometry was determined. The dentists were also asked whether in their opinion the use of an endodontic post leads to a stabilisation the root and a reduction of the risk of fracture.

Prosthetic restoration

Depending on tooth type (anterior, premolar, or molar), the participants were asked how often they restored endodontically treated teeth with a crown. Further, the dentists were asked whether they routinely included endodontically treated teeth in a prosthetic reconstruction (single crown, bridge, removable dental prosthesis).

The participants were shown pictures of clinical situations involving a premolar or a molar and were asked to name their preferred restoration type in such cases.

Materials used

The participants were asked how frequently they used different post types according to the tooth type involved. The choice of posts was as follows: prefabricated metal post, metal screws, cast post-and-core build-up, zirconia post, glass-fiber post. The dentists were asked to report which of four cement types they would prefer to use with metal or fiber posts: zinc-phosphate, resin-composite-based, glass-ionomer, and "other" cement.

Principles of preparation

Questions were asked about the desired post length in relation to the root length and the targeted fit when using prefabricated posts.

Evaluation

All data collected were entered in an Excel (Microsoft) table. The statistical analysis was descriptive. For each possible answer, the percentage of participants answering thusly was calculated.

For some questions, multiple partial answers were possible. Not all 95 participants provided complete answers to all questions. This was taken into account in calculating the percentages, so that the sum of partial answers did not always result in 100%.

Results

The average age of participating dentists was 50.7 (range: 25–66) years. 76% of the participants were male. Most participants (79%) reported having more than 15 years of professional work experience. Only 5% had been working as dentists for fewer than 5 years.

In terms of practice location, answers were relatively equally distributed between rural (52%) and urban (48%) areas.

38% of the dentists surveyed reported restoring over 50 endodontically treated teeth per year; only a minority of 22% indicated doing so in fewer than 30 teeth.

When asked whether a post-and-core build-up strengthens an endodontically treated tooth and decreases its risk of fracture, 54% of those surveyed answered "no".

In terms of precision of fit of intracanal posts, 43% of the dentists answered that they preferred maximum fit (as tight as possible). 41% aimed for the precision of fit allowed by standardized diameter spaces. Only a minority considered a post space preparation without maximized post fit sufficient and accepted a wider gap between the root canal and post filled with composite cement.

Answers about the desired post lengths showed a clear trend towards "approximately $\frac{2}{3}$ of the root length" (43%); 12% of the participants answered "approximately $\frac{1}{3}$ of the root length", 27% replied with "approximately $\frac{1}{2}$ of the root length", and "maximum length possible" was reported by 18% of those surveyed.

The dentists would routinely use an endodontically treated tooth as an abutment tooth in a 3-unit fixed dental prosthesis (FDP) (78% of those surveyed), a 4-unit FDP (53%), or include such a tooth in a removable dental prosthesis (74%).

Tables 1 to 7 present the data on a) the use of different post types depending on tooth type and lesion morphology, b) luting material, and c) coronal restoration.

Discussion

The present survey was conducted to evaluate the current knowledge and preferences of Swiss dentists concerning the restoration of endodontically treated teeth. Only participants in continuing education seminars on "Postendodontic Restoration" were surveyed. The fact that almost 80% of the dentists surveyed restore over 30 endodontically treated teeth per year indicates that this topic is clinically highly relevant. The responses to the questionnaire show that the decision to place an endodontic post is chiefly based on the existing substance defect and tooth type. A retention depth of at least two-thirds the root length and an absolute precision fit with predrilled holes was the goal of most of those surveyed. In terms of post type, glass-fiber dominated, although metal post systems were at least occasionally still utilized.

The 95 questionnaires evaluated in this study represent a relatively small sample size compared to other surveys on similar topics (TINNER ET AL. 2001, n = 360, MORGANO ET AL. 1994, n = 909, NAUMANN ET AL. 2006, n = 6092, ECKERBOM & MAGNUSSON 2001, n = 892). In contrast to this study, the questionnaires in the other surveys were sent in anonymously and the response rate varied greatly, from 16% to 70%. In our study, the response rate was 100% due to the direct contact with the seminar participants.

Because of the interrogative, retrospective character of this study, most of the answers – particularly the quantitative ones – were subjective estimates by the surveyed dentists, which may deviate from the effective clinical numbers. Furthermore, it must be noted that the results are based on answers by interested seminar participants; thus, caution is indicated in generalizing to all Swiss dentists.

Stabilizing effect of endodontic posts

Surprisingly, when asked about the possible stabilizing function of a post build-up, almost 50% of those surveyed expressed the opinion that an endodontic post strengthens a non-vital tooth and therefore decreases the risk of fracture, regardless of whether the post is conventionally or adhesive-

ly luted. These results are comparable to those of a recent study from Germany, in which 54% of the surveyed dentists believed that an endodontic post reinforces the root (NAUMANN ET AL. 2006A). In contrast, only 29% of dentists surveyed in Sweden shared this opinion (ECKERBOM & MAGNUSSON 2001).

The consensus in the literature largely confirms that endodontic posts do not stabilize the root; rather, substance re-

moval during preparation of the post canal tends to weaken the root and hence increases the risk of fracture (AL-OMIRI ET AL. 2010, ASSIF & GORFIL 1994, LANG ET AL. 2006, SCHWARTZ & ROBBINS 2004). Although a short-term stabilization of the prepared root canal could be shown for adhesively luted posts (GONCALVES ET AL. 2006, MARCHI ET AL. 2008, SAUPE ET AL. 1996), it was also found that the adhesion in the root canal decreases

Tab. I Frequency of posts used (question: "How often would you estimate that you place a post in an endodontically treated tooth?")

	Anterior tooth	Premolar	Molar	Abutment in FDP (independent of tooth type)
very often (over 90%)	19 (20%)	18 (18.9%)	13 (13.7%)	24 (25.3%)
often (ca. 75%)	17 (17.9%)	18 (18.9%)	22 (23.2%)	20 (21.1%)
occasionally (ca. 50%)	34 (35.8%)	33 (34.7%)	17 (17.9%)	24 (25.3%)
rarely (ca. 25%)	21 (22.1%)	23 (24.2%)	37 (38.9%)	15 (15.8%)
never (0%)	2 (2.1%)	1 (1.1%)	4 (4.2%)	1 (1.1%)

Tab. II Use of posts depending on substance defect (question: "As of which lesion extent do you decide to place an intracanal post?")

	Anterior tooth	Premolar	Molar
always, even without substance defect	12 (12.6%)	11 (11.6%)	10 (10.5%)
when only 3 coronal walls remain (i.e., mesial or distal lesion)	10 (10.5%)	4 (4.2%)	4 (4.2%)
when only 2 coronal walls remain (mesial and distal lesion)	13 (13.7%)	16 (16.8%)	15 (15.8%)
when only 1 coronal wall remains (e.g., MOD with buccal lesion)	27 (28.4%)	44 (46.3%)	38 (40%)
when no walls are left, but a ferrule of at least 2 mm of dental hard substance remains	28 (29.5%)	23 (24.2%)	20 (21.1%)
only when neither walls nor a ferrule remain	5 (5.3%)	2 (2.1%)	10 (10.5%)

Tab. III Percentage of postendodontically crowned teeth depending on tooth type (question: "What percentage of endodontically treated teeth do you restore with a crown?")

	Anterior tooth	Premolar	Molar
very often (over 90%)	8 (8.4%)	10 (10.5%)	11 (11.6%)
often (ca. 75%)	28 (29.5%)	28 (29.5%)	26 (27.4%)
occasionally (ca. 50%)	28 (29.5%)	34 (35.8%)	35 (36.8%)
rarely (ca. 25%)	25 (26.3%)	19 (20%)	19 (20%)
never (0%)	1 (1.1%)	0 (0%)	0 (0%)

Tab. IV Percentage of different post types used to postendodontically restore an anterior tooth (question: "How often do you use the following types of post to restore an endodontically treated anterior tooth?")

	Metal post	Metal screw	Cast post build-up	Zirconia post	Glass-fiber post
very often (over 90%)	6 (6.3%)	1 (1.1%)	6 (6.3%)	3 (3.2%)	18 (18.9%)
often (ca. 75%)	6 (6.3%)	2 (2.1%)	10 (10.5%)	4 (4.2%)	14 (14.7%)
occasionally (ca. 50%)	8 (8.4%)	6 (6.3%)	10 (10.5%)	9 (9.5%)	19 (20%)
rarely (ca. 25%)	12 (12.6%)	11 (11.6%)	33 (34.7%)	11 (11.6%)	13 (13.7%)
never (0%)	27 (28.4%)	37 (38.9%)	12 (12.6%)	27 (28.4%)	15 (15.8%)

significantly with clinical loading (BITTER ET AL. 2012B). Hence, a long-term stabilising effect is questionable.

Indication for the use of intracanal posts

As expected, the present data demonstrate that the decision in favor of a post essentially depends on the available dental hard tissue. Compared with anterior teeth and premolars, posts are less frequently used in molars, and are applied when coronal tooth substance is severely reduced. This corroborates the recommendations in the current literature, according to which

endodontic posts are less frequently placed as anchorage for a supraconstruction in endodontically treated molars than in anterior teeth and premolars. The reason for this is a larger retentive surface, resulting from a relatively large pulp cavity, as well as the fact that vertical forces dominate in the posterior dentition, while shear forces occur hardly at all (NAUMANN ET AL. 2005).

It is noteworthy that on average, in every 9th tooth – independent of its location – an intracanal post is placed even if there is no other substance defect except of the endodontic



Tab. V Percentage of different post types used to restore an endodontically treated posterior tooth (question: “How often do you use the following types of post to restore an endodontically treated posterior tooth?”)

	Metal post	Metal screw	Cast post build-up	Zirconia post	Glass-fiber post
very often (over 90%)	4 (4.2%)	6 (6.3%)	4 (4.2%)	2 (2.1%)	10 (10.5%)
often (ca. 75%)	5 (5.3%)	14 (14.7%)	8 (8.4%)	2 (2.1%)	8 (8.4%)
occasionally (ca. 50%)	8 (8.4%)	12 (12.6%)	6 (6.3%)	4 (4.2%)	14 (14.7%)
rarely (ca. 25%)	15 (15.8%)	8 (8.4%)	24 (25.3%)	8 (8.4%)	17 (17.9%)
never (0%)	27 (28.4%)	24 (25.3%)	24 (25.3%)	36 (37.9%)	21 (22.1%)

Tab. VI Preferred luting material depending on post type (question: “Which luting material do you prefer for intracanal posts?”)

	Metal post	Fiber post
zinc phosphate cement	21 (22.1%)	1 (1.1%)
composite-based “cement”	25 (26.3%)	63 (66.3%)
glass-ionomer cement	36 (37.9%)	4 (4.2%)
other cement	4 (4.2%)	2 (2.1%)

Tab. VII Preferred postendodontic restoration (task: “Assess the following clinical situations and select your preferred definitive restoration.”)

		
composite build-up	12 (12.6%)	43 (45.3%)
composite build-up with post	24 (25.3%)	15 (15.8%)
adhesive ceramic restoration	19 (20%)	18 (18.9%)
post-and-core build-up and crown	44 (46.3%)	17 (17.9%)
partial crown, gold	0 (0%)	9 (9.5%)

access cavity (i.e., all coronal walls remain). One possible explanation for this is that almost 50% of the dentists surveyed believe that an intracanal post stabilizes the root.

However, a few dentists reported placing posts only when all tooth walls were absent and thus a ferrule effect provided by the restoration was impossible. Although this may be appropriate in molars as long as a restoration with retention in the pulp cavity (endocrown) is placed (BINDL ET AL. 2005), in premolars and anterior teeth it leads to a significant worsening of the prognosis. The literature has convincingly demonstrated the importance of an adequate ferrule of at least 1.5 mm when placing a crown on endodontically treated teeth; this is valid regardless of whether a post is used or not (JOTKOWITZ & SAMET, 2010, JULOSKI ET AL. 2012, NAUMANN ET AL. 2006B, PEREIRA ET AL. 2006, STANKIEWICZ & WILSON 2002). A recent prospective clinical 10-year study found that high failure rates must be expected when a ferrule is absent (NAUMANN ET AL. 2012).

In terms of endodontically treated teeth serving as abutment teeth in a FDP, it was clear that posts are more frequently employed. The more comprehensive the prosthetic reconstruction, the less frequently are endodontically treated teeth included in the prosthesis. This could be attributed to the higher failure rates of fixed dental prostheses which depend on non-vital abutment teeth. Thus, the study by De Backer et al. (2007) found 20-year survival rates of 83% when only vital abutment teeth were included in the prosthesis, but only a 61% survival rate after 20 years when an endodontically treated abutment was used (DE BACKER ET AL. 2007).

Post length

The question about preferred post length showed that over 60% of the dentists aimed for an intracanal anchorage of at least $\frac{2}{3}$ the root length. In the survey by TINNER ET AL. in 2001, almost 80% of Swiss dentists still did this. This shows a change in preferred post length in the last decade.

In the age of conventionally cemented endodontic posts, the selected length and design had a decisive influence on their retention (FERNANDES ET AL. 2003, HOLMES ET AL. 1996, STANDLEE ET AL. 1978). In recent years, an increasing number of in vitro studies have been published which suggest that the smaller retention surface with shorter posts can be compensated by adhesive cementation techniques (BORELLI ET AL. 2012, NISSAN ET AL. 2001, SCHMITTER ET AL. 2010, WEGNER ET AL. 2006, ZICARI ET AL. 2012). This assumption was confirmed in a relatively recent retrospective clinical study: the follow-up of 864 teeth showed that insertion depth had no significant influence on the survival probability of prosthetically restored teeth (WEGNER ET AL. 2006).

The better bond strength in the coronal root third vs. that in the apical sections is seen as an advantage of reducing post length (PERDIGAO ET AL. 2006), as are the better access for and controllability of the steps performed in the adhesive technique. A shortened canal preparation also considerably decreases the perforation risk, particularly in curved roots (ALOMARI ET AL. 2011, HUYSMANS ET AL. 2007).

Post fit

The question on the desired precision of fit when using prefabricated endodontic posts yielded a clear result. With over 84%, the majority of the surveyed dentists strove to achieve an absolute or at least good fit after form-congruent predrilling. Only a minority of participants thought that a relative precision of fit was sufficient and the gap resulting from the lack of a pilot hole could be filled in with composite cement.

Through form-congruent post canal preparation, the mandatory precision of fit between post and canal wall demanded by conventional cementation (SCHMAGE ET AL. 2005, SORENSEN & ENGELMAN 1990) inevitably leads to a significant reduction of canal wall thickness (HUYSMANS ET AL. 2007) and thus also the rigidity of the root (LANG ET AL. 2006).

In adhesive cementation of glass-fiber posts, form congruency between post and root canal seems less important, because neither the pull-out strength of the post (BITTER ET AL. 2012A, PERDIGAO ET AL. 2007) nor the fracture resistance of the restored teeth are negatively influenced (BÜTTEL ET AL. 2009). Furthermore, a recent study found no correlation between the width of the intracanal cement joint and the fracture resistance in teeth restored with glass-fiber posts (KRSTL ET AL. 2011). On this basis, a post canal prepared by careful removal of the root canal filling and cleaning the canal walls to maximize substance preservation seems, from today's perspective, a good alternative to conventional, invasive drilling of standardized holes.

Post type

The present results show that overall – independent of tooth type – more metal posts (directly or indirectly fabricated) than glass-fiber posts are used. For years, the question about the optimal post material has been intensively discussed in the literature (BOLLA ET AL. 2007, DIETSCHI ET AL. 2007, 2008, FERNANDES ET AL. 2003, HEYDECKE & PETERS 2002). Recent systematic reviews based on prospective clinical studies point to tentatively better survival rates when glass-fiber posts are used (CAGIDIACO ET AL. 2008, THEODOSIOPOULOU & CHOCHLIDAKIS, 2009).

Besides glass-fiber posts, cast post build-ups in the anterior dentition and metal screws in the posterior region tend to be preferred. In general, prefabricated metal posts and zirconia posts are rarely used. Compared with the present study, the majority of Swiss dentists in the study by TINNER ET AL. (2001) reported most frequently using cast post-and-core build-ups in the anterior region and metal posts with plastic core build-ups in the posterior dentition.

Despite the greater technical efforts and the limited esthetic outcomes, cast post-and-core build-ups can still be recommended as an alternative in postendodontic restoration. According to the literature, they have a survival rate of over 90% after eight years (JUNG ET AL. 2007). In contrast, metal screws with survival rates of 76% after one year (SCHMITTER ET AL. 2007) and 50% after five years are no longer recommendable. The major cause of failure is root fracture (SCHMITTER ET AL. 2011), which consequently lead to extraction of the tooth. Given the available alternatives, the use of metal screws is not advisable.

Restoration

A majority of the surveyed dentists (50%–75%) provide crown restorations on endodontically treated teeth. Non-vital anterior teeth received crowns somewhat less frequently than did non-vital molars and premolars.

Some recommendations on crowning endodontically treated teeth can be derived from the literature. One retrospective clinical study showed that endodontically treated teeth without crown restorations had a 6-times higher failure rate after ten years (AQUILINO AND CAPLAN, 2002). Similarly, NAGASIRI & CHITMONGKOLSUK (2005) also found that crowned, non-vital molars had a higher survival probability than directly restored molars. In the latter case, the prognosis crucially depended on

the remaining dental hard tissue; the prognosis was good if both marginal ridges were maintained. However, the data of these two retrospective studies must be interpreted with caution, as both studies lacked a standardized procedure for placing restorations. Thus it should be assumed that the worse prognosis for non-crowned teeth after endodontic treatment was additionally influenced by a selection bias.

No clinical data exists on the prognosis of endodontically treated teeth restored with ceramic or gold partial crowns compared to full crowns. In vitro studies suggest that partial crowns are adequate in posterior teeth, depending on the initial situation (DIETSCHI ET AL. 2008).

Most participants would place a resin-composite filling as the restoration of choice for the large MOD cavity presented to them as a clinical case example (Tab. VII). As opposed to indirect restorations, such resin-composite restorations allow maximum conservation of healthy dental hard tissue. However, a retrospective study by ADOLPHI ET AL. (2007) showed that endodontically treated premolars and molars restored with large resin-composite fillings more frequently exhibited fractures after six to eight years than did similarly restored vital teeth. Hence, in such cases, direct composite restorations are regarded as a semi-definitive solution. Regardless of this, it can be assumed that the wishes and/or financial situation of the patient exert a great influence on decisions made in daily practice.

Conclusions

The following conclusions can be drawn:

- The majority of the dentists surveyed restored over 30 endodontically treated teeth annually.
- The decision to place an intracanal post was mainly based on the remaining tooth substance and the tooth type.
- Most participants strove for a retention depth of at least $\frac{2}{3}$ the root length and an absolute precision of fit with pre-drilled pilot holes.
- In terms of post type, metallic posts were predominantly used, while an increasing application of glass-fiber posts was registered.

- Regardless of post type, composite cements were the most commonly used luting material.
- In cases of large fixed dental prostheses, endodontically treated teeth were included in the reconstruction to a limited extent.
- The predominant strategies employed by the dentists surveyed for restoring endodontically treated teeth in part agree with the current literature. The most frequent deviations from literature recommendations were found regarding choice of post length, desired fit of posts, and the fact that intracanal screws are still used.

Résumé

Le but de cette étude était d'évaluer l'opinion dominante et les connaissances des dentistes suisses en ce qui concerne les stratégies actuelles pour la restauration des dents dévitalisées.

Un questionnaire avec 17 questions a été distribué dans la période entre 2009 et 2011 aux 95 participants de cours de formation continue sur cette thématique.

La majorité des dentistes interrogés ont traité plus de 30 dents dévitalisées par année. La décision d'utiliser un tenon intracanal est principalement liée à la perte tissulaire et le type de dent (antérieure, molaire, prémolaire, pilier de pont). Une profondeur de rétention d'au moins deux tiers de la longueur des racines et une adaptation parfaite sont souhaitées par la plupart des répondants. En ce qui concerne le type de tenon, les tenons métalliques sont utilisés plus couramment, cependant l'utilisation des tenons en fibre de verre est de plus en plus fréquente.

Indépendamment du type de tenon, les ciments composites sont utilisés le plus souvent pour le collage intracanal.

Les stratégies en vigueur pour la restauration des dents dévitalisées sont partiellement cohérentes avec la littérature actuelle. Les différences les plus courantes sont le choix de la longueur de tenon, le degré d'adaptation souhaité des tenons et le fait que les tenons métalliques sont encore et toujours utilisés.

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