Survival of two post systems—Five-year results of a randomized clinical trial

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Objective: To assess the survival rate of two different post systems after 5 years of service with a prospective randomized controlled trial. Method and Materials: One hundred patients in need of a post were studied. Half of the patients received long glass fiber-reinforced posts, while the other half received long metal screw posts. The posts were assigned randomly. After at least 5 years (mean, 61.37 months), follow-ups were established. When a complication occurred prior to this recall, the type and time of the complication was documented. Statistical analysis was performed using the log-rank test and Kaplan-Meier analysis. Additionally, a Cox regression was performed to analyze risk factors. Results: The survival rate of fiber-reinforced posts was 71.8%. In the metal screw post group, the survival rate was significantly lower, 50.0% (log-rank test, \( P = .026 \)). Metal posts resulted more often in more unfavorable complications (eg, root fractures); consequently, more teeth (n = 17) had to be extracted. The Cox regression identified the following risk factors: position of the tooth (anterior vs posterior teeth), degree of coronal tooth destruction, and the post system (fiber-reinforced post vs metal screw post). Fiber-reinforced restorations loosened in several patients; in some of these cases (n = 6), patients did not notice this, leading to the extraction of teeth. Conclusion: Long metal screw posts should be used with great care in endodontically treated teeth. Besides the selection of the post system, other factors influence the survival of the restoration. (Quintessence Int 2011;42:843–850)

Key words: fiber post, metal screw post

Reconstruction of endodontically treated teeth is often necessary before the definitive restoration is placed, especially when the remaining coronal tooth structure is not adequate enough to provide retention and resistance for the definitive restoration.

Selection of the most suitable post system is challenging for clinicians, and numerous in vitro studies have been conducted to evaluate different aspects of posts. In the past decade, nonmetallic posts (zirconium, carbon fiber, quartz fiber, and glass fiber) have been introduced. Different aspects of post and core complexes were evaluated in a review,¹ and it was found that the fracture strength was slightly better for metal posts. An in vitro study² showed that the load to failure was greater for steel posts than in composite posts. Additionally, it was demonstrated in an in vitro study³ that serrated metal posts are more retentive than other posts: Standee and Caputo investigated the retention of endodontic dowels in an in vitro study and concluded that threaded, parallel-sided posts were the most retentive systems. King et al⁴ found in their in vitro study that fiber-reinforced endodontic posts do not perform as well as conventional precious alloy posts, since more failures occurred in the fiber-reinforced post group. Additionally, many clinicians prefer metal posts because they are easier to set.
Although several in vivo studies assessed different aspects of posts, there is a lack of randomized clinical trials with longer observation periods. Furthermore, most clinical data are based on retrospective studies that assess the effect of different clinical aspects such as occlusal contacts. However, analyzing retrospective data implies a systematic bias, since there are no standardized baseline conditions. In a recent review, it was concluded that “the lack of long-term controlled randomized clinical studies was the main hindrance to reaching a conclusive and undisputable opinion regarding endodontic posts in terms of tooth fracture and biomechanical behavior.” Thus, the present study could deliver valuable information.

The research hypothesis of this randomized, prospective study was that in teeth restored with conventionally cemented posts (Fig 1), adhesively luted posts (Fig 2), and in teeth restored with different complication rates after 5 years of service could be observed. The PICO questions were as follows:

- **Patients:** Adults needing an endodontic post because of severe coronal tooth decay
- **Interventions:** Placement of a fiber-reinforced post
- **Comparison:** Placement of a metal screw post
- **Outcome:** Complications (including tooth survival) after 5 years of service

**Fig 1** Clinical situation after the placement of a metal screw post.

**Fig 2** Clinical situation after the placement of a fiber-reinforced post.
METHOD AND MATERIALS

Study population
This prospective study was approved by the ethical approval board of the University of Heidelberg (approval no. L-072/2003).

One hundred patients needing new crowns, fixed dental prosthesis (FDP), or removable dental prosthesis (RDP) were included in this study. The inclusion criteria were patients who needed a new restoration of endodontically treated teeth that were endodontically treated at least 3 months prior to placement of the post, needed a post and core complex because of coronal tooth destruction (at least 40% of the crown had to be destroyed), were at least 18 years of age, did not have periodontal disease, and were not pregnant or lactating. All patients signed an informed consent form and were recruited during a 2-year period.

Post assignment and cementation
Two post designs were used in this study: fiber-reinforced posts (ER dentin post, Brasseler) and parallel-sided titanium screw posts (BKS, Brasseler). If a patient fulfilled the inclusion criteria, a post was assigned randomly (computerized randomization surveyed by a study nurse). If a patient received two or more posts, only one post, chosen randomly, was included in the study. The randomization list was managed by a study nurse not involved in the study. If a tooth had more than one root canal, the more preferable was selected (eg, the straighter canal). Each tooth received only one post.

All posts were placed by students 6 months to 1 year prior to graduation, so the level of experience was almost equal. Both metal screw posts and fiber-reinforced posts were placed according to the manufacturer’s instructions.

To place the metal screw posts, the root canals were enlarged to ISO 80 and tapped using the appropriate tapper (Brasseler). The metal screw posts extended to at least 50% of the length of the root canal. Radiographs were then acquired to assess the correct position of the metal screw post and the position was adjusted if necessary (for example, if the metal screw post did not cover 50% of the root canal length). The root canal was then rinsed with alcohol and dried with paper tips.

Metal screw posts were cemented using zinc phosphate cement (Harvard Dental) in accordance with the manufacturer’s guidelines. The cement was placed in the root canal with a lentulo. The metal screw post was set using the appropriate setter (Brasseler). Excess cement was removed.

Figure 3 shows a radiograph of a metal screw post in situ.
To place the fiber-reinforced posts, the appropriate post was selected and the root canal extended. The fiber-reinforced post extended to at least 50% of the length of the root canal and was replaced by a metal copy for acquisition of radiographs (Fig 4). The correct position of the post was then verified on the radiographs and adjusted as necessary. The fiber-reinforced post was defatted using alcohol. The root canal was pretreated by roughening (diamond-surfaced hand instrument, Brasseler), etching (37% phosphoric acid, Excite-DSC soft touch single dose [Ivoclar Vivadent]), rinsing, and drying. The fiber-reinforced posts were then luted using composite cement (Variolink II, Ivoclar Vivadent) in accordance with the manufacturer’s guidelines.

To standardize core buildup, a self-curing flowable adhesive core buildup system with a dentin adhesive system (Solobond, Voco) was used to reconstruct the coronal tooth structure. The core was applied using rubber dam. In four cases, it was not possible to use rubber dam.

The cores were then prepared to produce artificial crowns, FDPs, or crowns integrated in an RDP. The impressions were taken using Impregum (3M ESPE) or Optosil and Xantopren (Heraeus Kulzer).

**Follow-ups**

All patients were instructed to consult the Department of Prosthodontics only in the event of problems. After 1 and at least 5 years, patients were recalled to check the state of the posts. If failure occurred prior to the established recalls, the patient was to visit the Department of Prosthodontics. The results of the 1-year follow-up have been already reported.11

Neither the patient nor the examiner knew which post was placed. The 5-year recalls were performed by one dentist who had not previously been involved in the study. This guaranteed the blinding of the examiner. After the acquisition of radiographs, blinding of the examiner was abolished. The criteria for success were no complications with respect to the post (eg, tooth or post fracture, loss of retention, etc), intact restoration on the tooth, and no pain on palpation and percussion.

**Statistical analysis**

Statistical analysis was performed by SPSS 16.0.1 (IBM). For descriptive purposes, percentages were calculated. Additionally, Kaplan-Meier analysis was used to construct survival plots. Only if a failure occurred before the 5-year recall did the patient have to visit the Department of Prosthodontics.
Thus, the survival plots might include failures before the established recall.

The log-rank test was used to compare the survival of both types of posts, and a Cox regression was performed to identify potential risk factors.

RESULTS

During recruitment, 41 patients did not agree to participate in the study. These patients were 58.38 ± 11.22 years old (42.5% men, 57.5% women).

The study population consisted of 45 men (56.33 ± 12.95 years) and 55 women (54.56 ± 12.88 years). After 5 years, 19 patients did not come to the recall (dropout, 19%). Thus, 42 patients with metal screw posts (dropout, 16%) and 39 patients with fiber-reinforced posts (dropout, 22%) were included in the analysis.

Results for the fiber-reinforced posts

In the fiber-reinforced group, 11 failures were observed: two post core–crown complexes had to be recemented, two teeth had to receive a new crown (the crown cracked or severely chipped), and one tooth had to be observed because of an apical alteration. Six additional teeth had to be extracted because the post core–crown complex loosened, which the patient did not notice, and the tooth became decayed. Thus, the survival of teeth with fiber-reinforced posts was 71.8% (28 of 39).

Results for the metal screw posts

In the metal screw post group, 21 failures were observed. One post and one crown had to be recemented. One tooth needed a new post core and crown because the post core–crown complex loosened. Seventeen teeth had to be extracted (in most cases, the root fractured or a perforation in the buccal-oral direction was observed), and one tooth had to be observed because of an apical alteration. Thus, the survival rate was 50.0% (21 of 42), including the failure of one crown.

Comparison of survival

The log-rank test was used to assess differences between failures of the two post systems after 5 years and showed the differences to be significant ($P = .026$). Kaplan-Meier analysis was performed (Fig 5). The details for the groups are given in Fig 6.
Cox regression

The Cox regression was performed to identify potential risk factors.

The following variables were included in the analysis: position of the tooth (anterior vs posterior), the degree of coronal tooth destruction, the relationship between post length and length of the crown, the post system (metal screw vs fiber-reinforced post), the kind of restoration (removable vs fixed prosthesis), and the presence or absence of an antagonist.

The following variables had an influence on the survival of the post: Anterior teeth had a higher risk for failures \( (P = .008) \), teeth presenting higher coronal destruction had a higher risk for failure \( (P = .041) \), and teeth restored using metal screw posts had a higher risk of failure than teeth restored using fiber-reinforced posts \( (P = .02) \).
DISCUSSION

Glass fiber–reinforced posts have become popular in the last decade. The major advantage of fiber-reinforced posts is the fact that the Young modulus is closer to that of dentin. Consequently, glass fiber–reinforced posts induce less stress.\(^{12,13}\) However, metal posts are easier to place and are frequently used in dental practice. Thus, in the present study, these two common post systems were selected.

This present randomized and blinded study was conducted to assess the failure and survival rates of the two post systems.

The survival of fiber-reinforced posts was 71.8%, including the fracture of one crown. Signore et al\(^{14}\) assessed the clinical effectiveness of parallel-sided and tapered glass fiber posts in endodontically treated maxillary anterior teeth over a period of up to 8 years. The results showed a survival rate of approximately 98%. However, this was a retrospective study and only maxillary incisors were included. Another study\(^{15}\) assessed the 3-year survival of fiber posts and found a survival rate of 76.7%, which is comparable to our results.

In the metal screw post group in the present study, the number of failures was higher than in the fiber-reinforced group. This result is confirmed by another study.\(^{16}\) In a retrospective clinical study, the performance of fiber-reinforced and cast posts was compared: Clinical success was higher for the fiber group (95%) than for the cast post group (84%). In another study, the success of threaded posts was 60%.\(^{17}\) Fox et al concluded that the post design that most often fractured was a serrated and parallel design.\(^{18}\) This could explain the low survival of the metal screw posts in the present study. The failure characteristics were comparable with those in other studies\(^{19}\): Root fractures were rarely observed in teeth restored by use of fiber posts. More often, the crown/post core interface failed. This would enable clinicians to repair affected teeth. However, in several cases, patients did not notice that the post core–crown complex loosened, and caries decayed these teeth. The metal posts in the present study resulted in more unfavorable complications such as root fracture. This result is confirmed by an in vitro study\(^{20}\): Fiber posts provided an advantage over conventional posts that showed a higher number of irretrievable posts and unrestorable root fractures. The Cox regression showed that three variables had a significant influence on the survival: the position of the tooth (anterior vs posterior teeth), degree of coronal tooth destruction, and the post system. Naumann et al\(^{21}\) assessed risk factors for fiber-reinforced posts and also found that anterior teeth had a higher risk for failure than posterior teeth. Additionally, it is well established in the literature\(^1\) that ferrule height is an essential parameter for long-term success. Thus, the present randomized study could confirm these results.

The present randomized, clinical trial could demonstrate that long metal screw posts (that cover at least 50% of the length of the root canal) should be used in endodontically treated teeth with great care.

When selecting the post systems for this study, three major criteria were essential. First, both post systems had to be direct systems without the involvement of a dental laboratory. Second, one system should be an innovative one and the other system should be an established one. Third, both systems should be available at the study site and investigators should have experience with both systems.

However, several limitations have to be considered when the results are interpreted: The present study was performed in a pre-selected population (prosthodontics department of a university), and the treatment was performed by moderately experienced dental students. However, the treatment was performed under standardized conditions by dental students presenting comparable experience. To simulate clinical conditions, both metal screw posts and fiber-reinforced posts were placed according to the manufacturer’s instructions. Since the research hypothesis of the present study was that in teeth restored with adhesively luted posts and in teeth restored with conventional cemented posts, different survival rates after 5 years in service could be observed, it was necessary to accept some statistical uncertainty. Another factor that must be discussed is the randomization. In the present study,
post assignment was randomized with respect to the patient, but not with respect to tooth type.

**CONCLUSION**

The clinical performance of fiber-reinforced posts is superior to that of metal screw posts because the number of complications was lower after 5 years of service. Long metal screw posts should be used with great care in endodontically treated teeth. However, besides the selection of the post system, other factors also influence survival of the restoration.

**REFERENCES**