Clinical Studies of Fiber Posts: A Literature Review

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Purpose: This literature review aimed to find answers to relevant questions regarding the clinical outcome of endontically treated teeth restored with fiber posts. ***Materials and Methods:*** All clinical studies published since 1990 in journals indexed in MEDLINE were retrieved by searching PubMed with the query terms "fiber posts and clinical studies." The reference list of the collected articles was also screened for further relevant citations. The strength of the evidence provided by the reviewed papers was assessed according to the criteria of evidence-based dentistry. ***Results:*** Five randomized controlled trials (RCTs) on fiber posts have been published in peer-reviewed journals. A meta-analysis is not applicable to these studies since they do not address the same specific clinical question. Retrospective and prospective trials without controls are also available. ***Conclusions:*** Two RCTs indicate that fiber-reinforced composite posts outperform metal posts in the restoration of endontically treated teeth. However, this evidence cannot be considered as conclusive. Longer-term RCTs would be desirable. The placement of a fiber-reinforced composite post protects against failure, especially under conditions of extensive coronal destruction. The most common type of failure with fiber-reinforced composite posts is debonding. *Int J Prosthodont 2008;21:328–336.*

As with any newly introduced dental material or procedure, it is necessary to validate through clinical studies the use of fiber posts in the restoration of endodontically treated teeth (ETT). In vitro tests, particularly those involving fatigue cycles, aging procedures, or finite element analysis models, have the potential to predict the clinical outcome. However, laboratory findings should be confirmed by clinical evidence collected through in vivo studies with a retrospective or a prospective design.

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A systematic review on root canal posts for the restoration of root-filled teeth was prepared by Bolla et al and recently published in *The Cochrane Library*.[1] The primary objective of this review was to compare the clinical failure rates of different types of posts, including metal versus nonmetal posts and cast versus prefabricated metal posts. Only 1 randomized controlled trial (RCT) was considered to fulfill the primary objective, indicating that carbon fiber posts resulted in a significantly lower failure rate in comparison with cast posts.[2] However, Bolla et al found the study's inclusion criterion of "tooth with important loss of structure" too generic and suggested that it should have been more precisely defined in terms of number of residual dentin walls.[1]

The overall conclusion of Bolla et al's review was that more RCTs with at least 3 years of follow-up would be needed to confirm the superiority of fiber post restorations and, particularly, to assess the influence of the remaining tooth structure on the treatment outcome.[1]

It should, however, be noted that the review, although highly comprehensive and thorough, includes articles published up to September 2005 at the latest. The present literature review was therefore conducted with the intention to provide an update to Bolla et al's review by

Table 1 Summary of the Retrospective Clinical Trials Published in Peer-Reviewed Journals

Study	Mean observation period	No. of teeth included	Amount of residual coronal structure	Fiber post manufacturer	Type of fiber post	Type of restoration	Tooth type	Failure rate
Fredrikssonn et al, 1998[7]	32 mo	236	NS	Composipost (RTD)	Carbon	All-ceramic/metal-ceramic full crown Direct composite restoration	All teeth	2%
Ferrari et al, 2000[8]	31 mo	1,304	NS	Composipost Aestheti-Post Aestheti-Plus (RTD)	Carbon Quartz	All-ceramic/metal-ceramic Full crown	All teeth	3.2%
Ferrari et al, 2007[9]	90 mo	985	NS	Composipost Aestheti-Post Aestheti-Plus	Carbon Quartz	All-ceramic/metal-ceramic Full crown	All teeth	8%
Hedlund et al, 2003[10]	26 mo	65	NS	Composipost Endopost (RTD)	Carbon	All-ceramic/metal-ceramic Full crown/veneers	All teeth	3%
Segerstrom et al, 2006[11]	79 mo	99	NS	Composipost	Carbon	Metal-ceramic Full crown/direct resin restoration	All teeth	32.2%

NS = not specified.

including studies published in the last 2 years. The more particular objective was to verify whether the most recent literature effectively responds to clinical questions regarding the use of fiber posts that were still unanswered according to the previous study.

Materials and Methods

A MEDLINE search was conducted to retrieve all clinical studies on the use of fiber posts for the restoration of ETT published since 1990, when these materials were introduced.

The literature search aimed to find answers to the following clinical questions:

1. Do fiber posts represent a valid alternative to metal posts in the restoration of ETT?
2. Under what conditions of residual tooth structure can post placement be considered beneficial?
3. What is the most common type of failure for ETT that have been restored using fiber posts?

The electronic database PubMed was used for the search, using "fiber posts and clinical studies" as query terms. The reference lists of the retrieved articles were also screened for further relevant citations.

Two of the authors independently reviewed the articles. To assess the quality of the studies, it was verified whether the following criteria were met:

1. The number of patients per group, the type of restored teeth, and patient characteristics at baseline were reported.
2. The restorative procedure and materials were described in detail.
3. Patients were randomly assigned to the different treatment groups.
4. In prospective studies, loss to follow-up and survival rate were indicated.

Further, the level reached by the study on the ladder of evidence was considered.

From a chronologic point of view, the first information on the clinical use of fiber posts became available in the form of case reports, case series, and retrospective studies published in non-refereed journals.[3–6] However, these studies were excluded from the review because, although numerically relevant, some of them lacked a precise definition of the case selection criteria, the clinical procedure followed, or the parameters used to assess the clinical outcome.

Only peer-reviewed scientific papers published in journals indexed in MEDLINE were considered.

Results

Retrospective Studies

The retrospective studies described in Table 1 applied more rigorous selection and evaluation criteria. Fredrikssonn et al[7] evaluated the clinical outcome of Composiposts over a 2- to 3-year period. The study included 236 patients (91 men, 145 women), treated within 1 year by 7 Swedish dental clinicians. A total of 236 restored teeth (130 maxillary, 106 mandibular) were evaluated at an average interval of 32 months (range: 27 to 41 months). Each patient had his or her own recall program. The type of final restoration (metal-ceramic crowns in 80% of the cases, ceramic crowns in 10%, and composite restorations in 10%) and the

type of antagonist tooth or restoration were reported. However, no information was provided on the bonding system, cement, or composite resin for core buildup used for the restorations, most likely because several clinicians operating in different clinical settings were involved in the study. Radiographic evaluations of the treated tooth and the contralateral tooth, if present, were carried out. Finally, Plaque Index, Gingival Index, Bleeding Index, probing depth, and bone height were measured, and any change from baseline conditions was recorded. The parameters for clinical success were defined as follows: retention of the restoration, no objective or radiologic sign of endodontic failure, no post dislocation, and no post or root fracture. The success rate was 98%. Five teeth (2%) had to be extracted for reasons unrelated to the post system used. No statistically significant difference was reported in the assessed parameters either between treated and control groups or from baseline to final recall in restored teeth. The only significant difference was between treated teeth and contralaterals in the bone height measured on radiographs on the mesial aspect of the tooth.

In a retrospective study, Ferrari et al[8] evaluated the survival rate of 1,304 fiber post restorations performed by 3 operators over periods ranging from 1 to 6 years. The posts used were 804 Composiposts, 215 Aesthetic-Posts, and 249 Aesthetic-Plus posts, bonded with 4 different adhesive cement combinations. Information regarding tooth type and position, adhesive/cement system, and type of post was provided. Success was defined based on the following clinical and radiographic parameters: restoration in situ, no clinical or radiologic lesions resulting from the technique, absence of post displacement or decementation, and absence of post or root fracture. Forty-one teeth failed. In 25 cases, failure was caused by post decementation. In 16 cases, failure of the endodontic treatment was observed. The overall success rate was 96.8%. The authors pointed out that the failures caused by post decementation occurred in teeth retaining less than 2 mm of residual coronal dentin. In all cases of failure, teeth could be restored to function through post recementation.

Again with a retrospective design, the clinical performance of 3 types of fiber posts was assessed over a period of 7 to 11 years in the same patients of the previously mentioned study.[9] Nine hundred eighty-five posts were included in the study: 615 Composiposts, 160 Aesthetic-Posts, and 210 Aesthetic-Plus posts were placed into ETT. Four combinations of adhesive systems and luting agents were evaluated. Endodontic and prosthodontic results were recorded. A 7% to 11% failure rate was recorded for the 3 types of posts. Seventy-nine failures were noted. Thirty-nine were caused by failure of the endodontic treatment. Other failures consisted of 1 root fracture, 1 post fracture, 17 crown dislodgments, and 21 post debondings. The results indicated that fiber posts in combination with adhesive cements can be used routinely for restoring ETT. Mechanical failure of teeth restored with fiber posts can be related to the presence of a reduced amount of residual coronal structure.

Teeth restored with Composiposts were evaluated retrospectively by Swedish researchers.[10,11]

Hedlund et al reported a 3% failure rate over an average clinical service of 2.3 years for Composiposts (97%) and Endoposts (3%).[10]

The study by Segerstrom et al[11] included 99 Composiposts placed from 1 month to 10 years previously, with a mean service time of 6.7 years. Only 25 patients could be clinically examined, while for the other patients data were retrieved from records. Although about three quarters of the patients were lost to follow-up, it was concluded that the survival time of teeth restored with Composiposts was shorter than that previously documented for cast posts. No testing of cast post-and-core restorations was performed in this investigation for control purposes.

None of the mentioned retrospective trials was included in Bolla et al's review,[1] which focused on RCTs.

Prospective Studies

Table 2 provides a summary of the studies with a prospective design. In a trial started in 1995 with results at 45 months, Glazer[12] evaluated the clinical behavior of 59 post restorations carried out for 47 patients. The fiber posts used were Composiposts and Endoposts from the University of Montreal. Each tooth was covered with a metal-ceramic crown. Details were given on the materials used and the clinical procedures followed, as well as regarding patient subdivision according to age and teeth distribution. The study did not include molars. The selected teeth presented a tissue loss of at least 50%; a 2-mm-high ferrule of dentin was preserved at the coronal level. Complete data were collected for 52 teeth in 42 patients, because the remaining patients did not present for all yearly recalls. All clinical evaluations were performed by the same operator according to well-defined objective and radiographic parameters of success. Two failures resulted from unsuccessful endodontic treatment and 2 were failures of the restorative procedure (1 post debonding, 1 crown decementation), without root fractures. Failure data were statistically processed. The overall success rate was 89.6%, and the average survival time was 43.4 months. Anterior teeth had the most favorable clinical behavior, whereas the least positive outcome was noted for mandibular premolars.

The clinical performance of 3 different types of translucent posts (Aesthetic-Plus, DT, FRC Postec) was evaluated during a follow-up period of 2 years.[15] In this

Table 2 Summary of the Prospective Clinical Trials Published in Peer-Reviewed Journals

Study	Mean observation period	No. of teeth included	Amount of residual coronal structure	Fiber post brand name and manufacturer	Type of fiber post	Type of restoration	Tooth type	Failure rate
Glazer, 2000[12]	28 mo	59	NS	Composipost (RTD)	Carbon	All-ceramic/metal-ceramic full crown	All teeth	7.7%
Mannocci et al, 2002[13]	36 mo	117	Class II premolars	Composipost	Carbon	Direct composite/ Metal-ceramic crown	Premolars	6%
Malferrari et al, 2003[14]	30 mo	180	NS	Aestheti-Plus (RTD)	Quartz	All-ceramic/metal-ceramic full crown	All teeth	1.7%
Monticelli et al, 2003[15]	24 mo	225	2 walls remaining	Aestheti-Plus, DT (RTD) FRC Postec (Ivoclar-Vivadent)	Quartz Glass	All-ceramic full crown	Premolars	6.2%
Naumann et al, 2005[16]	24 mo	105	1–5 walls remaining	Luscent Anchor (Dentatus) FibreKor (Jeneric Pentron)	Glass	All-ceramic/metal-ceramic full crown	All teeth	12.8%
Naumann et al, 2005[17]	39 mo	149	NS	Luscent Anchor FibreKor	Glass	All-ceramic/metal-ceramic full crown	All teeth	19.7%
Grandini et al, 2005[18]	30 mo	100	Anterior teeth: 50% residual sound tooth structure Posterior teeth: 2–3 sound walls	DT	Quartz	Direct composite	All teeth	0%
Cagidiaco et al, 2008[19]	24 mo	162	NS	Composipost	Carbon	All-ceramic/metal-ceramic full crown	All teeth	7.3%
Ferrari et al, 2007[20]	24 mo	120	1–4 walls, ferrule, no ferrule	DT vs no post	Quartz	All-ceramic/metal-ceramic full crowns	Premolars	7.5%
Cagidiaco et al, 2007[21]	36 mo	120	1–4 walls, ferrule, no ferrule	DT vs no post vs Ever Stick (Stick Tech)	Quartz	All-ceramic/metal-ceramic full crowns	Premolars	9.1%
Schmitter et al, 2007[22]	14 mo	50 vs 50	NS	Glass-fiber posts (ER, Brasseler) vs metal screw posts (BKS, Brasseler)	Glass	Full crown	All teeth	Glass fiber: 6.5% Metal screw: 24.6%

NS = not specified.

study, premolars were tested. Three groups of 75 patients were formed, and each patient received a fiber post–composite core restoration covered with a porcelain crown. Aestheti-Plus and DT posts were bonded with a light-curing adhesive and a dual-curing resin cement, while self-curing materials were used for FRC Postec. Clinical and radiographic examinations were performed after 6, 12, and 24 months. Eight post debondings (3.5%) occurred at removal of the provisional crowns in teeth with less than 2 mm of dentin structure left at the coronal level. In all of these cases, the post was successfully reluted. Failure of the endodontic treatment was recorded in 6 premolars. Statistical analysis did not find any significant difference in the survival rate among the posts tested.

Another study[14] evaluated the 30-month clinical outcome of 180 ETT restored with Aestheti-Plus posts. Posts were luted with All-Bond 2 adhesive system and C&B resin cement. The core was built-up with Core-flo or Bis-Core and covered with all-ceramic or metal-ceramic crowns. Parameters considered as clinical failures were post decementation, detachment, or fracture; core or root fracture; and crown or prosthesis decementation. Evaluations were repeated at 6, 12, 24, and 30 months. The overall success rate was 98.3%. One cohesive failure and 2 adhesive fractures (1.7%) occurred during the removal of the provisional crown. The involved teeth were restored to clinical service. No root fracture was reported. A survival analysis of the data was performed with the Kaplan-Meier test. Based on the collected data, the authors concluded that the use of Aestheti-Plus posts for the restoration of ETT was clinically safe.

The studies by Glazer et al,[12] Monticelli et al,[15] and Malferrari et al[14] were not included in the Bolla et al review[1] because they followed only 1 group of patients.

Grandini et al[18] presented a 2-year preliminary clinical report on the use of fiber posts and direct resin composites for restoring ETT. Thirty-eight anterior and 62 posterior ETT were selected. DT posts were bonded with a 1-step adhesive (Bisco) and DuoLink dual-cure resin cement (Bisco). Direct restorations were performed using a micro-hybrid composite resin (Gradia Direct). Patients were recalled after 6, 12, 24, and 30 months, and the restorations were assessed according to clinical and radiologic criteria. After 30 months, 4 teeth exhibited periapical lesions, 5 showed chipping of the composite resin, and 6 had slight marginal staining. Based on these findings, the authors concluded that in a short-term period, direct composite resin restorations represent a viable treatment option. The trial by Grandini et al[18] was excluded from Bolla et al's review[1] because treatment was not randomized.

Naumann et al[16] reported on the survival of teeth affected by varying degrees of hard tissue loss and restored using tapered or parallel-sided posts. Eighty-three patients received a total of 105 posts. A dual-curing hybrid composite was used as the luting material, EBS-Multi was used as the adhesive system, and Clearfil Core was used for abutment buildup. Restored teeth were followed for a minimum of 24 months. The results showed that 3.8% of the restorations failed after 12 months. The failure rate increased to 12.8% after 24 months. The most frequent failure pattern was post fracture. No significant difference in failure frequencies emerged between the 2 types of posts. This study was excluded from Bolla et al's review[1] because only glass-fiber posts were tested.

More recently, Naumann et al[17] tried to identify risk factors for restoration failures by evaluating the survival of 3 types of glass-fiber posts (2 tapered and 1 parallel-sided) applied in teeth with different stages of hard tissue loss. One hundred forty-nine posts were followed up in 122 patients for 5 to 56 months. Higher failure rates were found for anterior teeth compared with posterior, for teeth with no proximal contacts compared with those having at least 1 proximal contact, and for teeth restored with single crowns compared with those restored with fixed partial dentures.

Cagidiaco et al[19] evaluated the 2-year outcome of fiber post–composite core restorations. The effect of baseline factors (tooth type, number of residual coronal walls, type of final restoration) on restoration failure was assessed. The consecutive sample included 150 patients. A total of 162 teeth were restored. After 23 to 25 months, all patients were evaluated. Logistic regression analysis was used to identify the combined effect of the variables recorded at the baseline examination ($P = .05$). The reported failure modes were post debonding (7 cases, 4.3%) and failure of the endodontic treatment (5 cases, 3.0%). Logistic regression analysis did not ascertain statistical significance of any of the variables recorded at baseline. It was concluded that fiber post–retained restorations had a satisfactory 2-year clinical outcome.[13,23,24]

Four RCTs[2,19] were considered in Bolla et al's review.[1]

In a clinical trial by Ferrari et al,[2] 100 ETT received fiber post–retained restorations (group 1). The other teeth (n = 100) were restored with cast posts and cores (group 2). All teeth were covered with porcelain-fused-to-metal crowns. All clinical procedures were performed by the same operator. Patients were recalled at 6 months and 1, 2, and 4 years. Some patients were also evaluated between recalls, in coincidence with periodic oral hygiene sessions or regular 6-month checkups. At recalls, intraoral and radiographic examinations were performed. Success parameters were defined as follows: restoration in situ, no clinical or radiologic lesions caused by the technique, absence of post displacement or decementation, and absence of post or root fracture. In group 1, the loss to follow-up over 4 years was 3%. A 95% success rate was reported. Failure of the endodontic treatment occurred in 2% of the cases. In group 2, loss to follow-up was limited to 2%, and an 84% success rate was recorded. Nine percent of the restored teeth underwent root fracture. Other failures were the result of periapical endodontic lesions (3%) or post displacement (2%). The statistical analysis showed a significant difference in failure rate between the 2 groups ($P < .001$). It also emerged that in the presence of cast posts and cores, root fractures were unrestorable. Conversely, for fiber post–retained restorations, in all cases of failure, the teeth could be restored to function through post recementation, preceded by endodontic retreatment as needed.

According to Bolla et al,[1] the RCT by Ferrari et al[2] fulfilled the primary objective of comparing the failure rate of metal versus nonmetal posts. However, the method of randomization was not specified, and the inclusion criteria lacked a precise quantification of the tooth structure loss in terms of retained dentin walls.

King et al[23] assessed the clinical performance of a carbon fiber–reinforced (CFRC) endodontic post (n = 16) in comparison with a conventional prefabricated metallic post (n = 10). Four failures were recorded in the CFRC post group at 24, 29, 56, and 87 months, compared with 1 failure in the control group at 84 months. The authors concluded that post-retained crowns using carbon material and a composite resin luting agent do not perform as well as conventional precious alloy posts. However, the small size of the experimental groups and the lack of statistical analysis of the data somewhat limited the strength of the results.

Restoration with a fiber post and composite resin was shown to be a better option than an amalgam restoration.[24] In this study, 2 experimental groups of endodontically treated premolars were evaluated: 109 teeth were restored with amalgam and 110 with fiber post and composite. No statistically significant difference was found between the proportion of failed teeth in the 2 groups. Significant differences were observed between the proportion of root fractures and caries, with more root fractures and a lower frequency of caries lesions observed in the teeth restored with amalgam at the 5-year recall.

Mannocci et al[13] aimed to compare the survival rates of endodontically treated premolars restored with full-crown coverage or a direct composite. The authors evaluated 2 experimental groups: 60 teeth restored with composite direct restorations (group 1) and 57 restored with metal-ceramics (group 2). Failures were categorized as root fracture, post fracture, post decementation, clinical and/or radiographic evidence of marginal gap between tooth and restoration, and clinical and/or radiographic evidence of secondary caries contiguous with restoration margins. No failures were reported at the 1-year recall. Decementations (1 in group 1, 2 in group 2) and clinical/or radiographic evidence of marginal gap between tooth and restoration (3 in group 1, 1 in group 2) were the only failure modes observed at the 2- and 3-year recalls, with no significant differences between the groups. In Bolla et al's review,[1] this RCT was found to be the only study addressing the secondary issue of the influence of the coronal restoration on the failure rate of posted teeth.

A randomized clinical trial of a glass fiber–reinforced post and a metal screw post was recently published.[22] The following parameters were recorded: tooth type (anterior versus posterior), length of the post in relation to root length, extent of coronal tooth destruction, ferrule height, type of restoration, and presence of antagonist contacts. The 1-year survival rate of fiber-reinforced post restorations was 93.5%. No root fracture was reported in the presence of fiber posts. Conversely, in the metal screw post group, the survival rate was 75.6%, and unfavorable complications, such as root fracture, were more frequent. Tooth type and degree of coronal tooth destruction influenced the survival of metal screw posts but did not affect the 1-year clinical service of fiber post restorations.

Two recent clinical trials also investigated the role of the residual coronal dentin and of the presence of a 2-mm-high ferrule on the 2- and 3-year survival rate of endodontically treated premolars restored with and without fiber posts. Teeth were then covered with porcelain-fused-to-metal crowns.[20,21]

The aim of the 2-year prospective clinical trial was to assess whether the amount of residual coronal dentin and the placement of a fiber post had a significant influence on the survival of restored pulpless premolars.[20] A sample of 240 patients provided 6 groups of 40 premolars in need of endodontic treatment. The following experimental groups were defined, based on the amount of dentin left at the coronal level, and on the presence or absence of a ferrule: group 1: all coronal walls were left intact; group 2: three coronal walls were preserved; group 3: two coronal walls were maintained; group 4: only one coronal wall was present; group 5: ferrule effect—no coronal wall was retained, although a collar of dentin at least 2 mm in height was preserved circumferentially; and group 6: no ferrule effect—no coronal wall retained and less than 2 mm of dentin present circumferentially. Within each group, in half of the teeth selected at random, a DT Light Post (RTD) post was luted inside the root canal with Prime&Bond NT Dual Cure adhesive system and dual-cure resin cement Calibra (Dentsply Caulk). In the remaining half of the premolars, no post was placed. All teeth were covered with a porcelain-fused-to-metal crown. Cox regression analysis was applied to assess the influence on failure rate of the presence or absence of the post as well as of the amount of residual coronal dentin. No root or post fractures and no failures of the core buildup were recorded in post-retained restorations. The failure modes reported for these teeth were post debonding (9 cases) and failure of the endodontic treatment (2 cases) in combination with post decementation. All failures occurred in teeth retaining only the ferrule (group 5) or deprived even of that protective effect (group 6). In the absence of the post, 36 failures were recorded, 12 in group 6, 10 in group 5, 6 in group 4, 6 in group 3, and 2 in group 2. In 9 cases, failure was the result of root fracture, while the other 27 failures were caused by crown displacements. In 6 cases, failure of endodontic treatment was also reported. Posted teeth had a significantly higher success rate than those restored without a post. Kaplan-Meier plots showed that the amount of residual coronal dentin had an influence on the failure-free time of the restorations. Cox regression analysis revealed that regardless of the amount of coronal hard tissue loss, post placement resulted in a significant reduction of failure risk for endodontically treated premolars.

The aim of a 3-year clinical trial was to assess whether the amount of residual coronal dentin and the placement of Ever Stick fibers or a fiber post had a significant influence on the survival of restored pulpless premolars.[21] Ever Stick fibers were proposed as an alternative to fiber posts for restoring endodontically treated teeth.[25–29] A sample of 360 patients provided 6 groups of 60 premolars in need of endodontic treatment. Groups were defined based on the amount of

Table 3 Retrospective and Prospective Clinical Trials Comparing Fiber Posts and Metal Posts for the Restoration of Endodontically Treated Teeth

Study	Mean observation period	No. of teeth included	Amount of residual coronal structure	Fiber post manufacturer	Type of fiber post	Type of restoration	Tooth type	Failure rate
Ferrari et al, 2000[8] (prospective)	48 mo	100 vs 100	NS	Composiposts (RTD) vs cast post and core	Carbon	All-ceramic/metal-ceramic full crown	All teeth	Composipost: 2% Cast: 9%
King et al, 2003[23] (retrospective)	87 mo	10 fiber vs 16 metallic posts	NS	Carbon posts vs cast metallic posts	Carbon	Full crown	All teeth	Carbon: 40% Cast: 4%
Mannocci et al, 2005[13] (prospective)	60 mo	110 vs 109	Class II premolars	Carbon posts vs AMG	Carbon	Direct composite	Premolars	Carbon: 3.8% AMG: 2%
Schmitter et al, 2007[22] (prospective)	14 mo	50 vs 50	NS	Glass fiber posts (ER, Brasseler) vs metal screw posts (BKS, Brasseler)	Glass	Full crown	All teeth	Glass fiber: 6.5% Metal screw: 24.6%

NS = not specified. AMG = amalgam

dentin left at the coronal level. Within each group, in 20 teeth selected at random, a fiber post was inserted inside the root canal. In 20 premolars, Ever Stick fibers were placed, whereas in the remaining 20 teeth no endocanalar retention was provided. All premolars were covered with crowns. Cox regression analysis showed that regardless of the amount of residual coronal dentin, the presence of an endocanalar retention was a significant factor for the survival of root-treated crown-covered premolars. The decrease in failure risk was higher when DT posts were placed than when Ever Stick fibers were used.

Discussion

The clinical evidence currently available on fiber posts reaches the second highest level according to both the guidelines of the Agency for Health Care Policy and Research[30] and the classification of Richards and Lawrence.[31]

Five randomized controlled trials on fiber post restorations have appeared in peer-reviewed journals.[2,13,22–24] In both classifications mentioned, the strongest evidence is represented by a meta-analysis or a systematic review of multiple randomized controlled studies.[30,31] However, with regard to fiber post–retained restorations, a systematic review or meta-analysis is currently not feasible, since the few RCTs available did not address the same specific clinical question and tested fiber post placement against different control treatments, such as cast metal post,[2] screw metal post,[22] amalgam,[24] or no endocanalar retention.[20,21] In another RCT by Mannocci et al,[13] the influence of the coronal restoration on the survival of ETT was assessed by comparing direct composite with full cast coverage.

With regard to the comparison of fiber posts with metal posts (cast posts and cores,[2,8] luted,[13,23] and screwed posts[22]), 1 retrospective[8] and 4 prospective[2,13,22,23] clinical studies are available (Table 3).

After reviewing the studies published up to September 2005, Bolla et al[1] concluded that more RCTs were needed to confirm the superiority of fiber-reinforced post-and-core systems.

An RCT comparing a glass-fiber post and a parallel-sided titanium screw was recently published and revealed that the short-term clinical performance of the glass-fiber post was superior to that of the metal screw.[22] The study appears reliable with regard to sample selection, definition of coronal tooth destruction, method of randomization, dropout rate, and blinding of the examiner until radiographic examination. However, a possible limitation to the strength of the evidence may be found in the relatively short observation period of only 1 year. Bolla et al[1] recommend that future RCTs should provide at least 3 years of follow-up.

Clearer indications emerge concerning the failure patterns of restorations with fiber posts versus metal posts. Unfavorable complications, such as root fracture requiring tooth extraction, are more frequent with metal posts.[2,8,22]

Conversely, prospective and retrospective clinical studies have shown that debonding is the most common type of failure with fiber posts.[2,7–9,12,14–17,19–22] Loss of retention may result from failure of the bond to root canal dentin, which was proved to be less reliable than adhesion at the coronal level.[32–36] Also, delamination between luting material and the adhesive may occur.[37]Removal of the provisional crown is the clinical step during which post debonding most commonly occurs.[15] Several studies have pointed out the reversibility of this type of failure, which can be solved by post reluting.[2,8,9,15,19–21]

In the study by Bolla et al,[1] attention was drawn toward the relevance of tooth structure loss, and it was recommended that the outcomes of the different restorative systems be assessed with reference to the number of residual dentin walls. The need to more precisely define the anatomic criteria for tooth inclusion was therefore emphasized.

The influence of the retained coronal structure on the survival of ETT was recently investigated by 2 prospective clinical trials.[20,21] These studies highlighted the protective role of fiber post placement against the risk factor represented by the presence of a reduced amount of coronal dentin.[20,21] Under such conditions, ETT appeared to be susceptible to fracture over a 3-year clinical service period in the absence of the post.[21] Conversely, with post-restored teeth, post debonding was the only failure described. This was a more favorable pattern, since it is restorable by post rebonding.[21]

Confirmatory evidence was provided to the finding of previous laboratory studies[32,38–52] that the preservation of the ferrule effect positively contributes to load-carrying ability and survival of restored ETT. A ferrule has been defined as a 1.5- to 2-mm-high vertical band of tooth structure at the gingival aspect of a crown preparation, which adds to retention and provides a resistance form, increasing fracture resistance and enhancing the longevity of the restoration.[52] The effective role of the ferrule, formerly demonstrated for cast posts and cores,[38] was recently documented for bonded post restorations.[20,21]

In the RCT of Schmitter et al,[22] the degree of coronal destruction emerged as a risk factor for failure of metal screw–retained restorations, whereas the survival of fiber post restorations did not appear to be influenced. However, it should be considered that the follow-up was limited to 1 year. An influence of the residual crown tissue in the outcome of fiber post restorations may have emerged over a longer observation time.

Further risk factors for failure of fiber post restorations were identified as tooth type (with anterior teeth being at higher risk than posterior teeth), absence of proximal contacts, and restoration with a single crown compared with a fixed partial denture.[17]

Other relevant clinical aspects of ETT deserve further attention, such as the influence of post extension inside the root and of crown proportions in the mesiodistal, buccolingual, and gingivo-occlusal dimensions. In the clinical trial by Schmitter et al,[22] the length of the post in relation to root length was not found to be a significant factor for failure of either fiber or metal posts. However, it should be considered that 1 year may be too short a time for the clinical relevance of this variable to emerge.

Conclusions

The review of the available clinical evidence on the use of fiber posts for the restoration of endodontically treated teeth leads to the following conclusions:

1. Two randomized controlled trials currently indicate a superior performance of fiber posts compared with metal posts in the restoration of endodontically treated teeth. However, this evidence cannot be considered as conclusive; longer-term clinical trials taking into consideration the influence of the residual coronal structure on the clinical outcome of the different restorative systems are still needed.
2. Recent prospective clinical trials indicate that the placement of a fiber post may play a protective role against restoration failure, especially under conditions of substantial coronal destruction, such as in teeth retaining only a 2-mm-high ferrule or even deprived of the ferrule effect.
3. The most common type of failure when using fiber-reinforced composite materials is post debonding, while root fracture is a rare event for endodontically treated teeth restored with fiber posts.

References

1. Bolla M, Muller-Bolla M, Borg C, Lupi-Pegurier L, Laplanche O, Leforestier E. Root canal posts for the restoration of root filled teeth. Cochrane Database Syst Rev 2007;(1):CD004623.
2. Ferrari M, Vichi A, Garcia-Godoy F. Clinical evaluation of fibre-reinforced epoxy resin posts and cast post and cores. Am J Dent 2000;13:15B–18B.
3. Rovatti L, Mason PL, Dallari A. Nuove ricerche sui perni endocanalari in fibra di carbonio. Minerva Stomatol 1994;43:557–563.
4. Rovatti L, Mason PN, Dallari A. Nuove Ricerche sui Perni Endocanalari. Bologna: Martina Ed, 1999.
5. Bolla M, Mediani E, Muller M, Rocca JP. Le systeme Composipost: étude clinique et analyse critique. Inf Dentaire 1995;7:499–504.
6. Dallari A, Rovatti L. Six years of in vitro/in vivo experience with Composiposts. Compendium 1996;17:57–61.
7. Fredrikssonn M, Astback J, Pameius M, Arvidson K. A retrospective study of 236 patients with teeth restored by carbon fibre reinforced epoxy resin posts. J Prosthet Dent 1998;80:151–157.
8. Ferrari M, Vichi A, Mannocci F, Mason PN. Retrospective study of the clinical performance of fiber posts. Am J Dent 2000;13:9B–13B.
9. Ferrari M, Cagidiaco MC, Goracci C, et al. Long term retrospective study of the clinical performance of fiber posts. Am J Dent 2007;20:287–291.
10. Hedlund SO, Johansson NG, Sjogren G. A retrospective study of pre-fabricated carbon fibre root canal posts. J Oral Rehabil 2003; 30:1036–1040.
11. Segerstrom S, Astback J, Ekstrand K. En retrospectiv langtidsstudie av tander restaurerade med prefabricerade kolfibreforstarkta epoxystift. Swed Dent J 2006;30:2–8.
12. Glazer B. Restoration of endodontically treated teeth with carbon fibre posts—A prospective study. J Can Dent Assoc 2000;66: 613–618.
13. Mannocci F, Bertelli E, Sheriff M, Watson TF, Pitt Ford TR. Three-year clinical comparison of survival of endodontically treated teeth restored with either full cast coverage or with direct composite restoration. J Prosthet Dent 2002;88:297–301.

14. Malferrari S, Monaco C, Scotti R. Clinical evaluation of teeth restored with quartz fiber-reinforced epoxy resin posts. Int J Prosthodont 2003;16:39–44.
15. Monticelli F, Grandini S, Goracci C, Ferrari M. Clinical behavior of translucent-fiber posts: A 2-year prospective study. Int J Prosthodont 2003;16:593–596.
16. Naumann M, Blankenstein F, Dietrich T. Survival of glass fibre reinforced composite post restorations after 2 years—An observational clinical study. J Dent 2005;33:305–312.
17. Naumann M, Blankenstein F, Kiebling S, Dietrich T. Risk factors for failure of glass fibre-reinforced composite post restorations: A prospective observational clinical study. Eur J Oral Sci 2005;113: 519–524.
18. Grandini S, Goracci C, Tay FR, Grandini R, Ferrari M. Clinical evaluation of the use of fiber posts and direct resin restorations for endodontically treated teeth. Int J Prosthodont 2005;18:399–404.
19. Cagidiaco MC, Radovic I, Simonetti M, Tay FR, Ferrari M. Clinical performance of fiber post restorations in endodontically treated teeth: 2-year results. Int J Prosthodont 2007;20:293–298.
20. Ferrari M, Cagidiaco MC, Grandini S, De Sanctis M, Goracci C. Post placement affects survival of endodontically treated premolars. J Dent Res 2008;86:729–734.
21. Cagidiaco MC, Garcia-Godoy F, et al. Placement of FRC prefabricated or custom-made posts affects the three-year survival of endodontically treated premolars. Am J Dent 2008 (in press).
22. Schmitter M, Rammelsberg P, Gabbert O, Ohlmann B. Influence of clinical baseline findings on the survival of 2 post systems: A randomized clinical trial. Int J Prosthodont 2007;20:173–178.
23. King PA, Setchell DJ, Rees JS. Clinical evaluation of a carbon fibre reinforced endodontic post. J Oral Rehabil 2003;30:785–789.
24. Mannocci F, Qualtrough AJE, Worthington HV, Watson TF, Pitt Ford TR. Randomized clinical comparison of endodontically treated teeth restored with amalgam or with fibre posts and resin composite: Five-year results. Oper Dent 2005;30:9–15.
25. Le Bell AM, Tanner J, Lassila LV, Kangasniemi I, Vallittu P. Bonding of composite resin luting cement to fibre-reinforced composite root canal posts. J Adhes Dent 2004;6: 319–325.
26. Lastumaki TM, Lassila LV, Vallittu PK. The semi-interpenetrating polymer network matrix of fibre-reinforced composite and its effect on the surface adhesive properties. J Mater Sci Mater Med 2003;14:803–809.
27. Mannocci F, Sherriff M, Watson TF, Vallittu PK. Penetration of bonding resins into fibre-reinforced composite posts: A confocal microscopic study. Int J Endodont 2005;38:46–51.
28. Lassila LV, Tanner J, Le Bell AM, Narva K, Vallittu PK. Flexural properties of fibre reinforced root canal posts. Dent Mater 2004; 20:29–36.
29. Le Bell AM, Lassila LV, Kangasniemi I, Vallittu PK. Bonding of fibre-reinforced composite post to root canal dentin. J Dent 2005;33: 533–539.
30. Acute Pain Management: Operative or Medical Procedures and Trauma. Rockville, MD: Agency for Health Care Policy and Research, 1992.
31. Richards D, Lawrence A. Evidence-based dentistry. Br Dent J 1995;179:270–273.
32. Schwartz RS, Robbins JW. Post placement and restoration of endodontically treated teeth. J Endod 2004;30:289–301.
33. Bitter K, Meyer-Lueckel H, Priehn K, Kanjuparambil JP, Neumann K, Kielbassa AM. Effects of luting agent and thermocycling on bond strengths to root canal dentine. Int Endod J 2006;39:809–818.
34. Cury AH, Goracci C, de Lima Navarro MF, et al. Effect of hygroscopic expansion on the push-out resistance of glass ionomer-based cements used for the luting of glass fibre posts. J Endod 2006;32:537–540.
35. Sadek FT, Goracci C, Monticelli F, et al. Immediate and 24-hour evaluation of the interfacial strengths of fibre posts. J Endod 2006; 32:1174–1177.
36. Ferrari M, Goracci C, Sadek FT, Monticelli F, Tay FR. An investigation of the interfacial strengths of methacrylate resin-based glass fibre post-core build-ups by their components. J Adhes Dent 2006;8:239–245.
37. Mannocci F, Bertelli E, Watson TF, Pitt Ford T. Resin-dentin interfaces of endodontically-treated restored teeth. Am J Dent 2003; 16:28–32.
38. Stankiewicz NR, Wilson PR. The ferrule effect: A literature review. Int J Endod 2002;35:575–581.
39. Sorensen JA, Engelman MJ. Ferrule design and fracture resistance of endodontically treated teeth. J Prosthet Dent 1990;63:529–536.
40. Barkhordar RA, Radke R, Abbasi J. Effect of metal collars on resistance of endodontically treated teeth to root fracture. J Prosthet Dent 1989;61:676–678.
41. Isidor F, Brondum K, Ravnholt G. The influence of post length and crown ferrule length on the resistance to cyclic loading of bovine teeth with prefabricated titanium posts. Int J Prosthodont 1999;12:78–82.
42. McLean A. Predictably restoring endodontically treated teeth. J Can Dent Assoc 1998;64:782–787.
43. Assif D, Bitenski A, Pilo R, Oren E. Effect of post design on resistance to fracture of endodontically treated teeth with complete crowns. J Prosthet Dent 1993;69:36–40.
44. Morgano SM, Brackett SE. Foundation restorations in fixed prosthodontics: Current knowledge and future needs. J Prosthet Dent 1999;82:643–657.
45. Gegauff AG. Effect of crown lengthening and ferrule placement on static load failure of cemented cast post-cores and crowns. J Prosthet Dent 2000;84:169–179.
46. Nicholls JI. The dental ferrule and the endodontically compromised teeth. Quintessence Int 2001;32:171–173.
47. Zhi-Yue L, Yu-Xing Z. Effects of post-core design and ferrule on fracture resistance of endodontically treated maxillary central incisors. J Prosthet Dent 2003;89:368–373.
48. Pereira JR, de Ornelas F, Conti PCR, do Valle AL. Effect of a crown ferrule on the fracture resistance of endodontically treated teeth restored with prefabricated posts. J Prosthet Dent 2006;95:50–54.
49. Akkayan B. An in vitro study evaluating the effect of ferrule length on fracture resistance of endodontically treated teeth restored with fibre-reinforced and zirconia dowel systems. J Prosthet Dent 2004;92:155–162.
50. Tan PLB, Aquilino SA, Gratton DG, et al. In vitro fracture resistance of endodontically treated central incisors with varying ferrule heights and configurations. J Prosthet Dent 2005;93:331–336.
51. Sorrentino R, Salameh Z, Zarone N, Tay FR, Ferrari M. Effect of post retained composite restoration of MOD preparations on the fracture resistance of endodontically treated teeth. J Adhes Dent 2007;9:49–56.
52. Sorrentino R, Monticelli F, Goracci C, et al. Effect of post-retained composite restorations and amount of coronal residual structure on the fracture resistance of endodontically-treated teeth. Am J Dent 2007;20:269–274.