Long-term retrospective study of the clinical performance of fiber posts

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ABSTRACT: **Purpose:** To retrospectively evaluate the long-term clinical performance of three types of fiber posts after a service period of 7-11 years. **Methods:** 985 posts were included in the study: 615 Composiposts, 160 Æstethic Posts and 210 Æsthetic Plus Posts were placed into endodontically treated teeth. Four combinations of dentin adhesives/luting materials were used. Endodontic and prosthodontic results were recorded. **Results:** A 7-11% failure rate was recorded for the three types of posts. 79 failures in total were noted; 39 due to endodontic reasons, 1 root fracture, 1 fiber post fracture, 17 crown dislodgements and 21 due to post debonding. The mechanical failures were always related to the lack of coronal tooth structure. The results indicated that fiber posts in combination with bonding/luting materials may be used routinely for restoring endodontically treated teeth. Mechanical failure of restored teeth with fiber posts can be related to the amount of residual coronal structure. (*Am J Dent* 2007;20:287-291).

CLINICAL SIGNIFICANCE: The use of fiber posts in combination with adhesive restorative materials can provide a long term clinical success in endodontically treated teeth.

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Introduction

Technological advances in fiber-reinforced materials have resulted in a continuous evolution of fiber posts, with the latest generation of these posts overcoming some of the limitations of metallic posts in terms of esthetic appearance, failure modes, and clinical performance.[1-16] The mechanical properties and failure mechanisms of fiber posts were recently compared to those of metallic posts,[17-19] and to endodontically treated teeth that were restored without posts.[20,21] The results of these studies indicated that failures were often associated with irreversible root fractures with the use of metallic posts or in the absence of post placement. Conversely, coronal failures occurred more with the use of fiber posts, so that the failed restorations were salvageable. This difference in the failure mode may, by and large, be due to the greater amount of tooth structure that must be removed for the placement of a metallic post.[22] Moreover, when endodontic retreatment is indicated,[11] fiber posts may be more easily removed than metallic or ceramic posts.[23]

Since post placement and root canal treatment are regarded as major causes of root fractures, crown coverage has been routinely recommended as a protective measure.[24,25] A positive association between crown placement and the survival of endodontically treated teeth was observed when the loss of tooth structure was extensive.[26,27] The deflection characteristics of bonded fiber-reinforced composite posts demonstrated that they may protect remaining tooth structures.[28]

Retrospective and prospective clinical studies on the use of fiber posts for restoring endodontically treated teeth have been encouraging.[29-40] The survival rates of fiber posts ranged from 2-7.7% in retrospective studies and from 1.7%-12.8% in prospective studies, with the absence of root fractures. As these studies were all short-term studies that reported the performance of fiber posts after 2-3 years of clinical service, long-term clinical trials are required to determine if the previously reported findings are clinically significant. Thus, the objective of this study was to evaluate the clinical outcome of three different types of fiber posts luted with four combinations of bonding/luting materials that have been in service for 7-11 years. The null hypothesis tested was that there were no differences in the clinical performance of the three types of fiber posts during long-term clinical service.

Table 1. Baseline data.

Type of fiber posts		Age interval and average (months)	No. of subjects
C-Posts	(n= 840)	(18-68 m; m= 46 m)	719
AP	(n= 215)	(18-12 m; m= 14 m)	201
APP	(n= 249)	(16-12 m; m= 13 m)	234
Total	(n=1304)		1168

Legend: C-Posts, AP: Æstheti Posts; APP: Æstheti Post Plus.

Materials and Methods

Eight hundred and fifty carbon fiber posts (C-Posts[a]), the first generation of fiber posts, were placed between January 1994 and November 1997; 215 Æstheti Posts,[a] the second generation of fiber posts that consisted of quartz fibers instead of carbon fibers, were placed between December 1997 and April 1998; and 249 Æstheti Post Plus,[a] the third generation of fiber posts, were placed between January 1998 and December 1998. A total of 719 subjects were treated with the 850 C-Posts, 215 subjects with the 249 Æstheti Posts and 234 subjects with the 290 Æstheti Post Plus (Table 1). The age of the subjects ranged from 20-84 years with a mean age of 53 years. Three dentists participated in the placement of these posts.

All the teeth were previously endodontically treated with cold lateral compaction of gutta-percha and eugenol-free sealer.[b] In the molar roots, only one post was placed in the palatal root of maxillary and in the distal root of mandibular molars, with at least 5 mm of gutta-percha remaining apically. The fiber posts were bonded with different combinations of

Table 2. Distribution of the three generations of fiber posts placed clinically between 1994-1998 and the frequency of the types of tooth treated.

Post Type	Location	Tooth type: Central incisor	Lateral incisor	Canine	Pre-molar	Molar	Total (985)
C-Post	Maxilla	65	62	68	68	71	334
	Mandible	53	49	38	70	61	281
						Subtotal:	615
Æstheti Post (AP)	Maxilla	16	18	12	15	22	83
	Mandible	15					77
						Subtotal:	160
Æstheti Post Plus (APP)	Maxilla	29	25	15	21	25	108
	Mandible	18	21	14	36	24	102
						Subtotal:	210

Table 4. Combination between bonding system and fiber post related to failures.

	C-Post	AP	APP	Total	Failures
AB2	480	34	20	534	24
SBMPP	41	12	6	59	17
SB1	50	52	99	201	18
OS	44	62	85	191	20
Total	615	160	210	985	79
Failures	43	13	23		79

Legend: C-Posts, AP: Æstheti Posts; APP: Æstheti Post Plus; AB2: All Bond 2; SBMPP: Scotchbond MultiPurpose Plus; SB1: Scotchbond 1; OS: One Step.

dentin adhesives and resin cements: All Bond 2[c] and One-Step[c] in combination with C&B[c] resin cement, Scotchbond Multi-Purpose Plus[d] in combination with Opal luting composite[d] and Scotchbond 1[d] (Single-Bond[d]) with Rely X[d] resin cement. Core build up was performed with different resin composites. Bis-Core,[c] a self-curing composite, was mainly used with C-Posts and Æstheti Posts while light-curing composites were used with Æstheti Plus Posts.

The final restorations of the treated teeth at the last recall consisted of porcelain-metal restorations (56%), ceramic crowns (30%) and resin-composite restorations (14%). Of the opposing teeth still at the baseline, 38% had fixed restorations, 22% were restored with a removable denture, 34% occluded with unrestored teeth and 6% were not in occlusion.

Recall – 80% of the subjects treated were recalled for evaluation by simple randomization with random number tables.[25] Distribution of the three generations of fiber posts and the frequency of the types of tooth treated is reported in Table 2. The recalled patient pool consisted of 580 subjects with 615 C-Posts, 145 subjects with 160 Æstheti Posts and 186 subjects with 210 Æstheti Post Plus. The age of the recalled subjects ranged from 26-79 years with a mean age of 48 years.

The clinical examinations were carried out independently by two experienced operators. The observers were not blinded in the clinical examination as this was not possible. The treatment outcome was assessed by clinical and intraoral radiographic examinations. Radiographs were taken of each fiber post with the long-cone technique and Ultraspeed films.[e] The radiographs were examined with approximately x5 magnification. The outcome was considered successful if the post and core remained *in situ*, without clinical or radiographic signs of technical failures, loss of retention, root fracture or post fracture.

A logistic regression model was applied to the final recall data. Treatment outcome (success *vs.* failure) represented the dichotomous dependent variable, whereas post type, dental arch (maxillary *vs.* mandibular), and tooth position within the arch (anterior *vs.* posterior segment) were investigated as independent categorical variables in the model.

Table 3. Length of clinical service of the different posts. Number of failures per type of post.

Type of fiber posts		Failures (n)	Age interval and average (months)	No. of subjects
C-Posts	(n=615)	43 (7%)	(8-10aa, m=10.2)	580
AP	(n=160)	13 (8%)	(7aa, m=7.3)	145
APP	(n=210)	23 (11%)	(7aa, m= 7.1)	186
Total		79	(7-10aa, m= 7.9)	911

Legend: C-Posts, AP: Æstheti Posts; APP: Æstheti Post Plus; aa: years.

Table 5. Type of failures.

	Fract/root	Debonding	Dislodg/ crown	Endo	Fract/post
C-Posts	0	13	10	19	1
AP	0	3	1	9	0
APP	1*	5	6	11	0
Total	1	21	17	39	1

*Abutment of a debonded bridge.

C-Posts, AP: Æstheti Posts; APP: Æstheti Post Plus; Fract/root: fracture of the root; Dislodg/crown: Dislodgment of the crown; Endo: Endodontic failure; Fract/post: Fracture of the post.

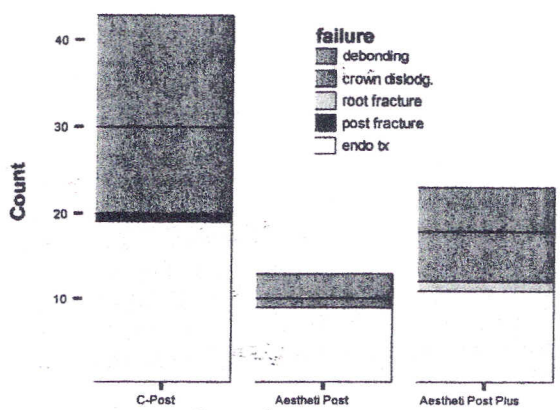

Figure. Failure distribution.

Results

Length of clinical service of the different posts is shown in Table 3. The C-Posts remained in service for 8-11 years, with mean service duration of 10.2 years. The Æstheti Posts remained in service for 7-7.9 years, with mean service duration of 7.5 years. The Æstheti Post Plus remained in service for 7-7.5 years, with mean service duration of 7.2 years. A total of 79 failures were recorded at the end of these service periods, with 43 failures occurring in the C-Post group, 13 failures in the

Æstheti Post group, and 23 failures in the Æstheti Post Plus group (Table 3). Correlation between bonding system and fiber post related to failure is reported in Table 4.

Table 6. Type of failure per type of tooth (n= 79).

Post type	Location	Tooth type: Central incisor (5/4)	Lateral incisor (5/5)	Canine (5/5)	Pre-molar (12/14)	Molar (13/11)	Total*
C-Post	Maxilla	2/1	2/1	1/2	4/3	4/3	13/10
	Mandible	2/1	2/2	2/1	4/1	3/2	13/ 7
						Subtotal:	26/17
Æstheti Post (AP)	Maxilla	0/1	1/0	0/0	1/3	1/1	3/ 5
	Mandible	1/0	0/1	0/1	0/1	1/0	2/ 3
						Subtotal:	5/ 8
Æstheti Post Plus (APP)	Maxilla	0/1	0/0	1/0	2/4	2/3	5/ 8
	Mandible	0/0	0/1	1/1	1/2	2/2	4/ 6
						Subtotal:	9/14

* 39 failures were endodontic and 40 were related to the restoration. Five teeth were extracted for replacement with implants.

Distribution of types of failures is reported in Table 5 and the Figure. Of the 985 posts examined from the 911 recall subjects, 21 failures were attributed to debonding of the post with dislodgment of the crowns. In one case, a root fracture was observed in the abutment of a partially debonded bridge. In 17 cases, only dislodgement of the crown, with total or partial fracture of the core abutment was noted. All debonded posts were originally bonded to teeth with less than 2 mm of remaining coronal dentin and two residual walls. In two cases, partial debonding of the crown/bridge occurred. Each case was caused by extensive leakage beneath the restoration and subsequent decay of the abutment. The remaining 39 failures were due to refractory periapical lesions. Thirty-five of these endodontic failures were asymptomatic and were discovered during radiographic examination. The other four endodontic failures exhibited clinical signs and symptoms during the recall appointment. Distribution of failures per type of tooth is reported in Table 6.

The type of post was found to be a non-significant factor for the failure event (Wald test, $P > 0.05$). Conversely, dental arch and tooth position within the dental arch were significant risk factors for failure, with upper and posterior teeth being more likely to fail than lowers and anterior teeth. Wald statistics and odds ratios with 95% confidence intervals are reported for the significant variables in Table 7. It should be pointed out that in posterior teeth failure was most commonly due to an ineffective endodontic treatment.

Only one root fracture was found. This tooth was a premolar with a very small amount of root dentin at the coronal third of the root. Fracture occurred between the coronal and medium thirds of the root. The tooth was subsequently extracted.

Discussion

As no significant differences were found among the three types of fiber posts luted with the four different types of adhesive/luting materials, we have to accept the null hypothesis tested. Retrospective studies on the clinical performance of fiber posts have previously been published.[31-33,35] They are often unable to ensure an adequate control of all the variables that might affect the clinical outcome. On the other hand, all other clinical reports on fiber post performance suffered from the same limitation in that relatively small sample sizes were presented.[31,33,35,41-44] Thus, with the large number of restorations recalled after long-term clinical services, some useful information may be derived from a retrospective study of this nature. Unfortunately, the difference in size of each group did not allow performing statistical analysis of other variables such as different bonding systems and different types of restorations.

Table 7. Estimates of the logistic regression model.

	Wald	Sig.	Exp(B)-Odds ratio	95% C.I. for Exp(B)
Dental arch	34.62	< 0.001	0.098	0.04-0.21
Tooth position within the arch	44.96	< 0.001	0.068	0.03-0.15

The results of this clinical outcome study were not completely in line with the findings of previous retrospective studies,[31-33,35] in which survival rates of the tested posts were found to be in the range of 94-97%. In the present study, the survival rate was between 89-93%. The higher number of clinical failures may be attributed to the longer period of clinical service of the fiber posts examined.

Differences in the type of failures were also observed between the present study and a previously reported study.[32] In the latter, failure of the fiber posts was never associated with root fractures, with the most frequently encountered causes of failure being debonding of the post and endodontic failures. Debonding mainly occurred during the removal of provisional crowns and in teeth with less than 2 mm of remaining coronal dentin. In the present report, debonding of the final restorations was noted during their clinical service, and was also related to the small amount of coronal dentin that remained after endodontic treatment. In addition, 17 cases of crown dislodgement, one case of fractured post and one case of root fracture were identified. Dislodgement of the crowns occurred simultaneously with partial or total fracture of the abutments, in teeth with little remaining coronal tooth structure and with natural opposing dentition and heavy occlusion. The case of post fracture was due to overloading of the restored tooth with a crown and extracoronal attachment for a partial denture, while the case of root fracture was due to a very weak root canal wall that remained after endodontic treatment. Both of these fracture cases cannot be related to the mechanical properties of the posts but mainly to the operator. A recent study reported a fiber post failure of 12.8% after 24 months of clinical service, with the majority of the failures (9%) being post fractures.[45] However, the types of posts used in that clinical study were FibreKor[f] and Luscent Anchors[g]. These two types of posts were found to fail in less than 1000 cycles when they were loaded using three-point bending. Conversely the three types of posts tested in the present study were able to withstand 2,000,000 cycles under the same *in vitro* testing conditions.[46]

The present study also confirmed previous results that debonding of fiber post restorations after long term clinical service occurred predominantly in teeth that have little

remaining coronal tooth structure. The contribution of the ferrule effect on crown and post retention is well known[22,47-50] and the effect of non-uniform ferrule circumferential height on fracture resistance was highlighted in a recent study.[51] In the present clinical study, it was noted that crown dislodgement and fiber post debonding were always associated with the presence of less than two residual walls in the coronal part of the tooth and when natural dentition was present in the opposing arch. Thus, it is crucial to preserve as much coronal residual dentin as possible during post preparation and placement. Debonding of the fiber posts along long term clinical service may also be caused by the difficulty in achieving high bond strengths to intraradicular dentin[52-54] and to the high C-factors that may be encountered when bonding is performed in long narrow cavities such as post spaces and root canals.[55,56] As the bond strength to root canal dentin is considerably lower[57,58] than to coronal dentin,[59] disruption of the bonded interface may occur during occlusal loading. Propagation of these debonded sites ultimately results in the debonding of the posts and crowns when high stresses are encountered in teeth that possess inadequate ferrule height.

This clinical trial was performed in endodontically treated teeth restored with fiber posts. Recently, several lab investigations stated that the placement of a post does not have much added value to the strength of a post-core restorations,[39,40,60-65] while other studies showed the opposite and also that in case of failure, the type of fracture is mainly repairable when a fiber post was used and catastrophic when it was not placed.[20,21,27,37,43-45,59,66,67] However, no clinical data on endodontically treated teeth restored without posts are available and clinical trials would be desirable.

a. RTD, St. Egreve, France.
b. Kerr, Orange, CA, USA.
c. Bisco Inc., Schaumburg, IL, USA.
d. 3M ESPE, St. Paul. MN, USA.
e. Eastman Kodak Co, Rochester, NY, USA.
f. Pentron Clinical Technologies, Wallingford CT, USA.
g. Dentatus AB, Hägersten, Sweden.

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