Retrospective study of the clinical performance of fiber posts

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ABSTRACT: ***Purpose:*** To evaluate the clinical performance of C-Posts, Æstheti Posts and Æstheti Plus Posts after a period of clinical service ranging from 1-6 yrs. ***Materials and Methods:*** 1,304 posts were included in the study: 840 Composiposts, 215 Æstheti posts and 249 Æstheti Plus posts were placed into endodontically treated teeth. Four combinations of bonding/luting materials were used. The patients were recalled every 6 months and clinical and radiographic examinations were completed. Endodontic and prosthodontic results were recorded. Acturial Life Table statistical analysis and Mantel-Haenszel comparison of survival curve have been performed at 95% level of confidence. ***Results:*** The 3.2% failure rate was due to two reasons: 25 posts debonded during removal of temporary restorations, and 16 teeth showed periapical lesions at the radiographic examination. No statistical significant differences were found among the four groups. The results of this retrospective study indicate that fiber posts in combination with bonding/luting materials can be routinely used. (*Am J Dent* 2000;13:9B-13B).

CLINICAL SIGNIFICANCE: Fiber posts can be used in daily practice for restoring endodontically treated teeth. Root fractures cannot be correlated to these types of posts.

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Introduction

Metallic posts have been widely used for restoring endodontically treated teeth. Metal posts (*i.e.*, platinum alloys or titanium) are most commonly used because of their favorable physical properties and excellent biocompatibility. Unfortunately, their metallic color leads to a grayish discoloration of the root and consequently of the gingiva.[1] This unpleasant effect can be also determined by the discoloration of the root of endodontically-treated teeth. This can be a disadvantage particularly in anterior teeth. The unesthetic appearance of the root color can be very important clinically when single-unit all-porcelain crowns are used for restoring anterior teeth. Depending on the thickness and the opacity of both luting cement and all-ceramic restoration, the metal post and core may shine through or at least decrease the depth of translucency of the restoration.[2,3]

Different techniques of veneering the post and core have been proposed to solve the problem of the grayish coronal discoloration and to achieve the necessary masking when all-ceramic restorations are luted to teeth restored with metal posts and cores.[4-6] However, these methods cannot solve completely the problem because the metal posts still may shine through in the cervical and root areas. Recently, in order to solve this problem, several types of non-metallic white posts made by different ceramic systems were proposed.[7-10]

Unfortunately, a luted ceramic post is difficult to remove and, in case of endodontic retreatment, the root canal access is particularly difficult.[11] The ceramic posts are also very stiff and strong with no plastic behavior.[12-14] The stiffness of the ceramic posts can be less favorable clinically than that of fiber posts in respect to risk of root fractures.[15,16] In fact, a number of *in vitro* studies demonstrated that the fracture type is more benign with fiber posts than when metal or ceramic posts are used.[15,17-19]

In 1990, Duret *et al*[14] introduced a nonmetallic material, based on the carbon fiber reinforced principle, the Composipost[a] (or C-Post[a]). The main characteristic of fiber posts the similarity of the modulus of elasticity to dentin.[20] Then, new carbon fiber posts covered with quartz fiber posts (Æstheti Posts[a]) with a design very similar to that of the established carbon fiber ones, were produced. The purpose of these new posts was to provide better esthetic results by preventing the dark carbon fiber posts showing through the tooth. Recently, quartz fiber posts, without carbon fibers, were made (Æstheti Plus Posts[a]).

Different specific *in vitro* tests for posts and cores have been developed to tentatively address characteristics of the new systems and predict their clinical behavior. Although clinical tests are time consuming,[21] they must be performed in order to evaluate the real clinical behavior of new materials, such as posts and cores, bonding systems and luting resin cements.

The C-Posts, Æstheti Posts and Æstheti Plus Posts are new, so there are only few clinical studies of clinical performance on the first type of post and no long term data of the other two types of posts.[22-24]

This retrospective clinical and radiographic study evaluated the clinical performance of C-Posts, Æstheti Posts and Æstheti Plus Posts after 1-6 yrs of clinical service.

Materials and Methods

In the last 6 yrs, 1,314 fiber posts were placed by three dentists. Between January 1994 and November 1997 only C-Posts were used; then, between the end of 1997 and of April 1998 Æstheti Posts were also placed and finally, after January 1998, Æstheti Plus Posts were luted.

From each of the three dentists, 80% of the total number of patients treated with this system was selected by simple randomization with random number tables.[25] Acturial Life Table statistical analysis and Mautel-Haeusael comparison of survival curve were performed at 95% level of confidence.[26]

A total of 719 patients treated with 850 C-Posts, 215 patients with 249 Æstheti Posts and 234 patients with 290 Æstheti Plus Posts were selected for evaluation. The age of the patients ranged from 20-84 yrs (mean 53 yrs).

Table 1. Clinical distribution of posts.

	Incisors	Laterals	Canines	Pre2molars	Molars	Total
Maxilla	80	85	92	110	103	460
C-Posts						
Mandible	65	60	46	98	101	380
Total	145	145	138	208	204	840
Maxilla	25	26	15	21	28	109
Æstheti Posts						
Mandible	21	20	10	31	24	106
Total	46	46	25	52	52	215
Maxilla	34	30	20	26	30	130
Æstheti Plus Posts						
Mandible	21	24	16	30	28	119
Total	55	54	36	56	58	249

Data from the dental records were available at the time of examination and the records correlated well with examinations. As all patients had previously been included in an individual recall program, data were also obtained from the records of the remaining patients who were unable to participate in person.

The frequency of types of tooth treated is shown in Table 1. Length of clinical service of the different posts is shown in Table 2.

The final restorations of the treated teeth were metal ceramic restorations (52%), ceramic crowns (38%) and the remainder restored with resin-based composite (RBC). Of the opposing occluding teeth, 45% had fixed restorations, 20% were restored with a removable denture, 10% occluded with unrestored teeth and 5% were not in occlusion.

Clinical procedures

All roots were endodontically treated following lateral condensation of gutta-percha with eugenol-free sealer.[b] After no less than 48 hrs from the endodontic treatment the roots were prepared for receiving a post. In the molar roots only one post was placed, in the palatal root of maxillary and in the distal root of mandibular teeth.

After selection of appropriate drill size, the root canal space was prepared using preshaping and finishing drills[a] for a length of 8 mm. At least 4 mm of gutta-percha was left apically to seal the root apex. Then the posts were tried-in and consequently shortened with a diamond bur. Finally, the fiber posts were bonded with the selected bonding system and resin cement, strictly following manufacturers' instructions.

The fiber posts were bonded with different dentin bonding/resin cement combinations. The following bonding systems were used: All Bond 2[a] and One-Step[a] in combination with C & B[c] resin cement, Scotchbond Multi-Purpose Plus[c] in combination with Opal[d] luting composite and Scotchbond 1[c] (Single-Bond[c]) with Rely X[c] resin cement. The combinations between adhesive materials and fiber posts are reported in Table 3.

Then the teeth were build-up with a RBC. The build-up of the abutment core was performed with different RBCs: Bis-Core[a] self-curing RBC was mainly used on C-Posts and Æstheti Posts while Æliteflow[a] light-curing RBC was used for build-up abutment restored with Æstheti Plus Posts.

Parameters

The rate of success was assessed by clinical and intraoral radiographic examinations.

Table 2. Post distribution of service posts at the latest recall examination.

Type of posts	Age interval in months	(Average)	No of patients
Composiposts	18-68	(46)	840
Æstheti Posts	18-12	(14)	215
Æstheti Plus	16-12	(13)	249

Table 3. Combination between bonding system and fiber post (*debonding failures).

	Fiber posts	Æstheti posts	Æstheti Plus posts	Total	Failures
AB2	625 (11)	50 (2)	29 (/)	704	13(7*)
SBMMP	75 (7)	18 (1)	10 (5)	103	14 (6*)
SB1	78 (2)	64 (2)	110 (5)	252	9 (6*)
OS	62 (2)	83 (3)	100 (1)	245	6 (6*)
Total	840 (22)	215 (8)	249 (11)	1304	41 (25*)

25 posts failed because of debonding. All debonded posts were rebounded or replaced successfully. All debonded posts were originally bonded to teeth with less than 2 mm of coronal dentin remained. The other 16 failures were due to endodontic periapical lesions. Acturial Life Table statistical analysis and Mantel-Haenszel comparison of survival curve have been performed at 95% level of confidence.

Radiographs were taken of each fiber post with the long-cone technique and ultraspeed film.[e] A modified parallel technique was used. The radiographs were examined with approximately x5 magnification. The outcome was considered successful if the post and core were *in situ*, without clinical or radiographic signs of technical failures, loss of retention, root fracture or post fracture. During the prosthetic treatment, the stability of the resin core and the possible dislodgment of the posts during debonding procedures of temporary restorations.

The clinical examinations, in the practice of the two dentists, were carried out independently by the two operators. The observers were not blinded in the clinical examination as this was not possible. To obtain the maximum unbiased comparison, observers were calibrated.

Results

The duration in service of the Composipost dowels varied from 18-68 (mean 46) months (Table 2). The Æstheti Posts remained in place for a period ranging between 12-18 (mean 14) months and the Æstheti Plus Posts between 12-16 (mean 13) months.

Of the 1,304 teeth treated, 25 showed failure due to debonding of the post. All debonded posts were originally bonded to teeth with less than 2 mm of coronal dentin remaining. The other 16 failures were due to endodontic periapical lesions. Endodontic failures were discovered during radiographic examination in 16 teeth; these teeth were treated with C-Posts and showed an asymptomatic periapical lesion. The total amount of failures was 3.2%. The results showed no statistically significant difference among the four groups.[25] No root fracture, dislodgment of post or of the crown was found. The debonding failures were almost equally distributed among the four bonding/resin cement systems used in this clinical trial (Table 3).

The 25 failures due to debonding of the posts can be attributed to the bonding/luting/system, while the other 16 failures were clearly due to endodontic reasons. Thus, no technical failures due to the fiber posts were recorded.



Fig. 1. A preoperative clinical view of a patient in need of esthetic treatments of four incisors.

Fig. 2. Fiber posts were placed in two abutments. The first was a carbon fiber post, while in the other an Æstheti fiber post was used.

Fig. 3. The clinical results after placing four single unit porcelain crowns.



Fig. 4. A preoperative view of a patient with two unesthetic endodontically treated teeth.

Fig. 5. The two central incisors after preliminary preparation of abutments.

Fig. 6. The final abutments. Two posts were luted into root canals: an Æstheti Post and an Æstheti Plus post.


Fig. 7. The final result at the 3-yr recall.

Fig. 8. Radiograph of tooth depicted in Fig. 7.

Figs. 1-15 show representative cases from this study.

Discussion

Esthetic requirements for posts and cores became evident only since the introduction of more translucent, enamel-like all-porcelain restorations. These requirements are: (1) dentin-like core, (2) resistance to darkening of the restored tooth, crown and coronal aspect of the surrounding gingival tissues and (3) resistance to root discoloration.

The abutment is usually made from a RBC core material, which easily bonds to the carbon and experimental fiber posts with a resin cement. The employment of RBC for restoring the abutment can minimize the non-esthetic color of the carbon fiber post.

Some authors[14,15] have emphasized the necessity to use posts made with biomechanical properties similar to those of dentin. With regards to posts, fiber posts are the only available materials with this property.[20] The high rigidity of ceramic material could be advantageous by reducing the risk of fracture for the prosthetic crown but simultaneously can determine a potential danger by inserting a structure of much higher rigidity in the root.[21,27]

Different factors can influence the selection of the proper post system. All the tested post materials were bonded into the root canal. Recently it was demonstrated that the carbon and the esthetic experimental fiber show a good adhesion to resin cement, while the zirconium post showed unsatisfactory bonding.[17] The fiber posts do not need any special surface pretreatment. While microretention may be created into the zirconium post surface, the adhesion between the post and the resin cement was not uniform.[17] Finally, in case of re-treatment, the carbon fiber and the experimental posts are easily removed by a drill,[11] while the zirconium post, even using a diamond bur, hardly can be removed.

In this clinical study, the survival rate of fiber posts was 96.8%. The debonded posts were replaced or rebonded and the endodontically failed teeth were then retreated and restored. The survival rate of the fiber posts was similar to that found in other retrospective studies.[22-24,28-32] in laboratory studies on metallic posts, root fracture was the most frequent type of failure. One of the reasons for root fracture is that with the cast post and core the stress can be concentrated in uncontrolled areas where a fracture can start. Another reason for fracture can be that the cast post has retention due to friction

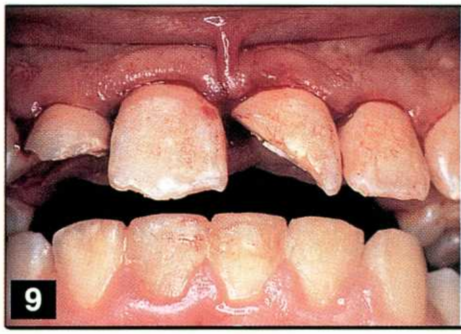
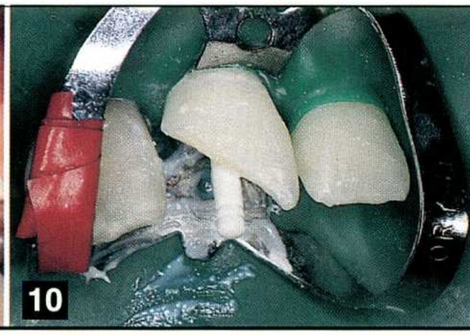


Fig. 9. A young patient after a trauma. Three incisors needed to be endodontically treated and restored.

Fig. 10. A clinical step of luting an Æstheti Plus post.

Fig. 11. The final clinical result.


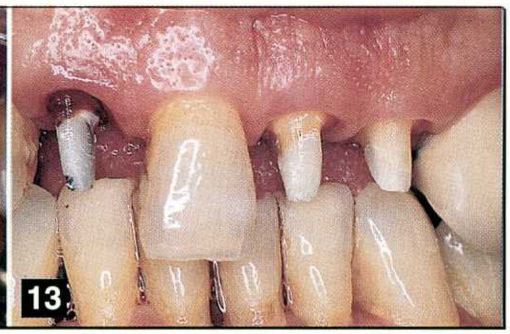

Fig.12. When a residual coronal thickness wider than 2 mm is present a build-up made of a fiber post is indicated.

Fig. 13. Fiber posts were luted on abutments of Fig. 12.


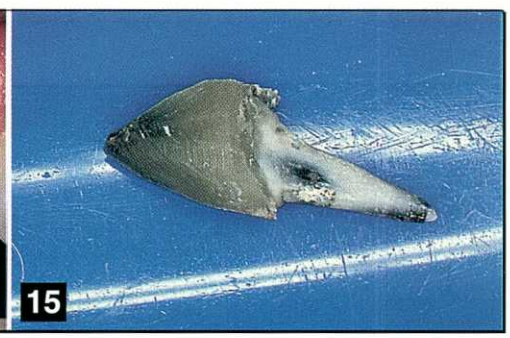

Fig. 14. When less than 2 mm of coronal thickness remains, a debonding failure of the post can take place.

Fig. 15. The post of Fig. 13 after debonding.

along root walls and this fact can transmit the stress directly to root structure; the area where dentin walls are thinner and less resistant. However, root fracture was never found in endodontically-treated teeth restored with any esthetic post.

In this study the most frequent type of failure was debonding of the post. All debonding failures occurred during removal of temporary crowns and in teeth with less than 2 mm residual coronal dentin structure. This finding agrees with Trabert *et al*[33] who found that the amount of remaining tooth structure was the most influential factor in predicting fracture resistance. Because the abutment teeth were not damaged by the debonding, all the teeth were restored again with a fiber post: in 50% of the cases the post was replaced, while in the others the same post was rebonded. In roots with periapical lesions, the fiber posts were removed following Sakkal's[11] technique. After removing the fiber post completely with drills, the endodontic therapy was performed and after a few months, the teeth were restored again. All failures recorded in this clinical study were recovered by proper therapies and the roots were not lost.

Originally, fiber posts were proposed in combination with a three-step bonding system (All-Bond 2) and proprietary resin cement (C&B). Recently, the so-called "one-bottle" adhesive systems have been proposed to simplify the clinical bonding procedure of direct restorative dentistry. The clinical indications of one-bottle systems may be increasing, although little data on testing for bonding fiber posts into root canals are available yet.[34,35]

The latest generation of adhesive systems provides acid etching to remove the smear layer and demineralize root dentin, so that a surface increase of dentin available for bonding is achieved and a fine network of collagen fibrils is exposed.[34-36] The infiltration of this organic network with resin monomers permits hybrid layer formation and creates resin tags with adhesive lateral branches, thus creating micromechanical retention of the resin into the demineralized dentin substrate.[37-39] Both types of bonding systems, the traditional three-step and the one-bottle systems tested in this study use the same micromechanical bonding mechanism and long-term clinical trials.[34-35]

Final conclusions on the use of fiber posts will depend on the results of ongoing prospective multicenter studies.

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References

1. Paul S, Schärer P. Post and core reconstruction for fixed prosthodontic restoration. *Pract Period Aesthet Dent* 1998;5:513-20.
2. Siebert C, Thiel N. Spinell/Luminary porcelain: Natural light optics for anterior crowns. *Quintessence Dent Technol* 1996;19:43-49.
3. Vichi A, Ferrari M, Davidson CL. The influence of ceramic and cement thickness on the masking of various types of opaque posts. *J Prosthet Dent* In press.
4. Rinaldi P. Esthetic correction of PFM restorations: A case report. *Pract Periodont Aesthet Dent* 1996;8:34-6.
5. Mutobe Y, Maruyama T, Kataoka S. In harmony with nature: Esthetic restoration of a nonvital tooth with IPS-Empress all-ceramic material. *Quintessence Dent Technol* 1997;20:83-106.
6. Frejilich S, Goodrace CJ. Eliminating coronal discoloration when cementing all-ceramic restorations over metal posts and cores. *J Prosthet Dent* 1992;67:576-77.
7. Kakehashi Y, Luthy H, Naef R, *et al.* A new all-ceramic post and core system: Clinical, technical and *in vitro* results. *Int J Period Rest Dent* 1998;18:587-593.
8. Kwiatkowski S, Geller WA. Preliminary consideration of the glass ceramic dowel post and core. *Int J Prosthodont* 1989;2:51-55.
9. Koutayas SO, Kern M. All-ceramic posts and cores: The state of the art. *Quintessence Int* 1999;30:383-392.
10. Irfan A. Yttrium-partially stabilized zirconium dioxide posts: An approach to restoring coronally compromised nonvital teeth. *Int J Periodont Rest Dent* 1998;18:455-465.
11. Sakkal S. Carbon-fiber post removal technique. *Compend Contin Educ Dent* 1998;20 (Suppl):S86-S87
12. Taira M, Nomura Y, Wakasa K, *et al.* Studies on fracture toughness of dental ceramics. *J Oral Rehabil* 1990;17:551-563.
13. Hochman N, Zalkind M. New all-ceramic indirect post-and-core system. *J Prosthet Dent* 1999;81:625-629.
14. Duret B, Reynaud M, Duret F. Un nouveau concept de reconstitution corono-radiculaire: Le composiposte (1). *Chirurg Dent France* 1990;540: 131-141.
15. Asmussen E, Peutzfeldt A, Heitmann T. Stiffness, elastic limit, and strength of newer types of endodontic posts. *J Dent* 1999;27:275-278.
16. Isidor F, Odman P, Brondum K. Intermittent loading using prefabricated carbon fiber posts. *Int J Prosthodont* 1996;6:131-136.
17. Mannocci F, Ferrari M. Intermitted loading of teeth restored using "quartz fibre", "carbon-quartz fibre" and zirconium root canal posts. *J Adhes Dent* 1999; 2: 158-166.
18. King PA, Setchell DJ. An *in vitro* evaluation of a prototype CFRC prefabricated post developed for the restoration of pulpless teeth. *J Oral Rehabil* 1990:17:599-609.
19. Sidoli GE, King PA, Setchell DJ. An *in vitro* evaluation of a carbon-fiber based post and core system. *J Prosthet Dent* 1997;785-789.
20. Martínez-Insua A, Da Silva L, Rilo B, *et al.* Comparison of the fracture resistances of pulpless teeth restored with a cast post and core or carbon-fiber post with a composite core. *J Prosthet Dent* 1998;80:527-532.
21. Dietschi D, Romelli M, Goretti A. Evaluation of post and cores in the laboratory: Rationale for developing a fatigue test and preliminary results. *Compend Contin Educ Dent* 1998; (Suppl):S65-S73.
22. Dallari A, Rovatti L. Six years of *in vitro/in vivo* experience with Composipost. *Compend Contin Educ Dent* 1998;20 (Suppl):S57-S63.
23. Mannocci F, Vichi A, Ferrari M. Carbon fiber *versus* cast post: A two year recall study. *J Dent Res* 1998;77:1259(Abstr 419).
24. Fredriksson M, Astback J, Pamenius M, *et al.* A retrospective study on 236 patients with teeth restored by carbon fiber-reinforced epoxy resin posts. *J Prosthet Dent* 1998; 80:151-157.
25. Lemenshow S, Hosmer DW Jr, Klar J, *et al. Adequacy of sample size in health studies*. Chichester, John Wiley & Sons, 1990.
26. Diem K, Lentner C. *Scientific tables*. Basel: Ciba-Geigy Limited, 1971.
27. Dean JP, Jeansonne BG, Sarkar N. *In vitro* evaluation of a carbon fiber post. *J Endod* 1998;12:807-810.
28. Ferrari M, Vichi A, García-Godoy F. A 4-yr retrospective study of fiber-reinforced epoxy resin posts *vs.* cast posts and cores. *Am J Dent* 2000;13:15B-18B.
29. Sorensen JA, Martinoff JT. Intracoronal reinforcement and coronal coverage: A study of endodontically treated teeth. *J Prosthet Dent* 1984;51:780-784.
30. Weine FS, Wax AH, Wenckus P, *et al.* Retrospective study of tapered, smooth post systems in place for 10 years or more. *J Endod* 1991;17:293-297.
31. Torbjoner A, Karlsson S, Odman PA. Survival rate and failure characteristics for two post designs. *J Prosthet Dent* 1995;73:439-444.
32. Mentik AG, Meenwisser R, Kayser AF, *et al.* Survival rate and failure characteristics of the all metal post and core restoration. *J Oral Rehabil* 1993;20:455-461.
33. Trabert KC, Caputo AA, Abou-Rass M. Tooth fracture-A comparison of endodontic and restorative treatments. *J Endod* 1978;4:341-345.
34. Ferrari M, Grandini S, Vichi A, *et al.* "One-bottle" and three steps adhesive systems used for bonding fiber posts into root canals under clinical conditions: A SEM investigation. *Proceedings of VII Congress of Italian Academy of Conservative Dentistry,* Bologna, May 2000; 27 (Abstr.16)
35. Ferrari M, Mannocci F. Bonding of an esthetic fiber post into root canal with a "one-bottle" system: A clinical case. *Int J Endodont,* In press.
36. Nakabayashi N, Pashley DH. *Hybridization of dental hard tissues.* Berlin: Quintessence, 1998.
37. Pashley DH, Ciucchi B, Sano H, *et al.* Permeability of dentin to adhesive agents. *Quintessence Int* 1993;24:618-631.
38. Chappell RP, Cobb CM, Spencer P, *et al.* Dentinal tubule anastomosis: A potential factor in adhesive bonding? *J Prosthet Dent* 1994;72:183-188.
39. Mjör IA, Nordahl I. The density and branching of dentinal tubules in human teeth. *Archs Oral Biol* 1996;41:401-412.