A study into application of fiber technology for endo posts

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Chapter 2  
Endo Posts

Fiber Post versus cast post and cores

Introduction

Endodontically-treated teeth with defective coronal aspects very often need to be restored with a post and core as foundation for the final restoration.\(^1\)-\(^3\) In the last decades, cast posts were most commonly used because of their favorable physical properties and biocompatibility. Unfortunately, several disadvantages associated with conventional cast post-and-core were found such as loss of retention of the post or of the crown, potential for post and root fractures and risk of corrosion when different metals are used in the system.\(^4\)-\(^8\) Although several factors are involved, some of these failures can be related to the mechanical properties of the posts.\(^9\) In particular, root fractures were mainly correlated to the shape and length of the post.\(^10\) The cast post core systems include components of different rigidity. Since the more rigid component (post), is able to resist forces without distortion, stress is transferred to the less rigid one (dentin), and causes the failure of it. The difference between modulus of elasticity of dentin and post material is a source of stress for the root structures. Therefore the use of resin-based composite (RBC), glass-ionomers and amalgam pins has been advocated with crown coverage\(^11\) in order to avoid the insertion of metal posts into the root canal.\(^12\) A carbon fiber post developed in France and introduced in the U.S. (Composipost or C-Post,\(^8\)) was proposed in order to overcome the disadvantages of metal posts.\(^13\) Carbon fiber posts consist of pyrroilitic carbon fibers arranged longitudinally in an epoxy resin matrix with the carbon component constituting 64% of the structure. The carbon fiber post exhibits high fatigue and tensile strength, and has a modulus of elasticity (stiffness) comparable to dentin.\(^13,\,14\) Its chemical nature is compatible with the Bis-GMA resins commonly used in bonding procedures. This post can be
bonded within root canal space with polymer dentin bonding agents and resin cements of similar flexibility, and effectively transmits stresses between the post and the root structure, reducing stress concentration and preventing fracture.\textsuperscript{13,14}

The Composipost system is relatively new, so there are only few long-term studies of clinical performances.\textsuperscript{15-17} These studies showed that the 2-3 yr clinical performance of carbon fiber posts was excellent.\textsuperscript{15-17}

This retrospective study evaluated the 4-yr clinical performance of endodontically treated teeth restored either with carbon fiber posts or cast posts.

\textbf{Materials and Methods}

Between January and July 1995, 200 endodontically-treated teeth with severe loss of tooth structures were selected and randomly divided into 2 experimental groups of 100 samples each. All the roots were endodontically-treated with the lateral condensation of gutta-percha and eugenol-free sealer. 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 distal root of mandibular teeth.

Group 1: After selection of appropriate drill size, the root canal spaces were prepared using preshaping and finishing drills\textsuperscript{a} for a length of 9 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. Composipost were bonded with All-Bond 2\textsuperscript{b} and C & B\textsuperscript{b} resin cement strictly following manufacturers' instructions. The teeth were built-up with Bis-Core\textsuperscript{b} self-curing RBC.

Group 2: The roots of this group were prepared for receiving a cast post-and-core. Then an impression of root canal spaces was made by reversible hydrocolloid materials (Optiloid\textsuperscript{c}) and poured in Type IV stone (Fuji Rock\textsuperscript{d}).
The post-and-cores were waxed and cast in precious alloy (Medior 3°), finished and tried into the root canals. The clinical procedures of post cementation were accomplished using zinc phosphate cement (Zinc Cement'). The abutments were temporized with resin crowns cemented with eugenol-free cement. All teeth received a porcelain-fused-to-metal crown as final restoration.

Periapical radiographs and clinical examination were performed before post cementation, immediately after, 6 months, 1, 2 and 4 yrs after crown cementation in order to evaluate crown retention, secondary caries and periapical and periodontal tissues. The radiographs were taken with the long-cone technique and ultraspeed film^9. The radiographs were examined with approximately x5 magnification. Comparisons were made with radiographs taken before, immediately after treatment and at recalls. Of the opposing occluding teeth, 60% had fixed restorations, 5% were restored with removable partial denture, 15% occluded with unrestored teeth, 20% were in occlusion with vital teeth restored with amalgam or RBC.

The rate of success was assessed by clinical and intraoral radiographic examinations. The outcome was considered successful if the post and cores were in situ, without secondary caries, clinical or radiographic signs of technical failures, endodontic infection, loss of retention, root fracture or post fracture. A single operator carried out the clinical evaluation in restored teeth. The frequency of types of teeth treated is shown in Table 1. All patients had previously been included in an individual recall program. The patients were recalled after 6 months, 1, 2 and 4 yrs.

The length of clinical service of Group 1 and 2 samples at last recall was 4 years.

Actuarial Life Table statistical analysis and Mantel-Hanszel comparison of survival curve was performed at 95% level of confidence.
### Table 1

<table>
<thead>
<tr>
<th>Incisors</th>
<th>Canines</th>
<th>Premolars</th>
<th>Molars</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group 1</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maxilla</td>
<td>12</td>
<td>13</td>
<td>19</td>
<td>13</td>
</tr>
<tr>
<td>Mandible</td>
<td>9</td>
<td>10</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td><strong>Group 2</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maxilla</td>
<td>15</td>
<td>18</td>
<td>18</td>
<td>9</td>
</tr>
<tr>
<td>Mandible</td>
<td>6</td>
<td>10</td>
<td>19</td>
<td>14</td>
</tr>
</tbody>
</table>

### Results

The results are summarized in Table 2.

**Group 1:** Of the total of 100 teeth treated in Group 1, three (3%) were excluded for missing the last recall exam. Due to periapical lesion, two teeth needed to be retreated endodontically. The remaining 95 teeth were classified as successful. No dislodgment or fracture of posts or roots was observed in the recalled 97 teeth. Dental caries were not detected in the post-treated teeth. Thus, no technical failures attributable to the carbon fiber post-and-core system were recorded.

**Group 2:** Of the 100 teeth treated with cast post-and-cores, two (2%) were excluded for missing the 4-yr recall exam. Due to periapical lesions, three teeth needed to be retreated endodontically. Nine teeth showed root fracture and two dislodgment of the crown. All these situations were noted at the last recall. No caries, fracture or dislodgment of the posts were noted.

Radiographic examination at 4-yr recall showed evidence of root fracture of nine roots. Four root fractures were noted in the abutments of two bridges of two different patients. The other five root fractures were found on teeth covered by single-unit porcelain fused-to-metal crowns. The result of statistical analysis showed a significant difference between Group 1 and 2 (p < 0.001).
Table 2

<table>
<thead>
<tr>
<th>Group 1 (Carbon fiber posts)</th>
<th>Group 2 (Cast post and cores)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Missing teeth</td>
<td>Missing teeth</td>
</tr>
<tr>
<td>3%</td>
<td>2%</td>
</tr>
<tr>
<td>Failures</td>
<td>Failures</td>
</tr>
<tr>
<td>2% (Periapical lesions 2%)</td>
<td>14% (Dislodgment of the crown 2%) (Root fractures 9%) (Periapical lesions 3%)</td>
</tr>
<tr>
<td>Successful</td>
<td>Successful</td>
</tr>
<tr>
<td>95%</td>
<td>84%</td>
</tr>
</tbody>
</table>

Discussion

There are conflicting reports on the ability of metal posts to reinforce endodontically-treated teeth.\(^{18-20}\) A more recent review of the literature suggests that many endodontically-treated teeth are not reinforced with the use of a metallic post, but the role of the post is only to support the abutment build-up material and consequently the final restoration.\(^{10,21,22}\) There are only few clinical studies of metallic-post success and failures. Sorensen and Martinoff\(^{20}\) noted 8.6% failures as a result of post dislodgement, root fractures or post perforations. Weine et al.\(^{23}\), reported 6.5% failures after 10 yrs or more and Torbjørner et al.\(^{8}\) reported 8.3% of failures after 2-3 yrs. Mentink et al.\(^{24}\) showed a success rate of 82% for anterior teeth and that recementation was the most frequent type of failure. The data of this clinical study related to cast posts showed 14% of failures were found for cast posts after 4 yrs of clinical service. 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 can be that the cast post has retention due to friction along root walls which can transmit the stress.
directly to root structure: in the area where dentin walls are thinner and consequently less resistant, a fracture can take place.

Endodontic failure (periapical lesions) was observed in 2% and 3% of Groups 1 and 2, respectively. The retreatment of teeth built up with fiber posts is simple, because the fiber post structure can be easily removed with a high speed bur and a drill. The retreatment of teeth restored with cast posts was more difficult because the metallic posts must be removed with a diamond bur mounted in a handpiece. The latest procedure required more working time, was more risky for root integrity and was more difficult to be completed than that followed for retreatting the two teeth of Group 1.

Another advantage is that fiber posts technique is less time-consuming than the technique for preparing a cast post and core in the laboratory.

An ideal post should have a modulus of elasticity close to that of root dentin and carbon fiber posts fulfilled this requirement. When a load was applied with an angle of approximately 35° to the long axis of the post, the modulus of elasticity of carbon fiber posts was approximately 21 GPa, while that of the dentin is approximately 18 GPa. More recently, similar results were obtained when a load was applied with an angle of 45° to the long axis of the post.

Recently, a cycling load test evaluating post-core restorations of teeth covered with metal crowns showed that carbon fiber post-composite core restorations were less likely to produce root fractures than stainless steel post-composite cores. Other in vitro studies confirmed that the fracture type is more benign when fiber post is used than when metal posts are used: with the metallic posts a relatively high proportion of the tooth fractures involved the root structures.

Composipost dowels are passive and are designed to being used with a bonding technique. A bonding system and resin cement establish a strong bond to the root canal dentin walls after removal of the smear-layer, demineralized dentin and increased surface available for bonding. The major elements which contribute to bond strength are tubular resin tag formation when tags bond well to the tubule walls, resin infiltration into
demineralized tubular dentin and side branches of the tubules. Several three-step and "one-bottle" systems were tested into endodontically-treated teeth and resin tag, adhesive lateral branch and hybrid layer formation was demonstrated under clinical conditions. However, for optimal results the manufacturer's instructions must be followed carefully.

The influence of different cements on retention of posts has been the subject of recent research. Several clinical advantages of the bonding/luting procedures of fiber posts are detectable. A study demonstrated that posts cemented with enamel-dentin bonding resin cements exhibited less leakage than when cemented with other cements (glass ionomer and zinc phosphate) and these results were also correlated with the hybrid layer and resin tag formation between root canal walls and resin.

From the results of this clinical study it can be stated that an ideal post should impart minimal stress on the tooth, provide adequate retention of the core, and should allow easy removal to permit endodontic retreatment, if necessary.

The survival rate of Composiposts found in this study was confirmed by other clinical retrospective investigations. However, final conclusions will depend on the results of ongoing multicenter studies.

a. RTD, Grenoble, France
b. Bisco Co., Schaumburg, IL, USA
c. EMS, Le Sentier, Switzerland
d. GC, Tokyo, Japan
e. Cendres & Metaux SA, Biel, Switzerland
f. SS White Manufacturing, Bristol, UK
g. Kodak-Pathe, Chalon-Sur Saone, France

References


Fiber posts after six years clinical service

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 as well as corrosion during time lead 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 unaesthetic appearance of 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 can not solve completely the problem because the metal posts still may shine through in the cervical and roots area. 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 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.\textsuperscript{15,17-19}

In 1990, Duret et al.\textsuperscript{14} introduced a nonmetallic material, based on the carbon fiber reinforced principle, the Composipost (or C-Post\textsuperscript{8}). The main characteristic of fiber posts was the similarity of the modulus of elasticity to dentin. Then, new carbon fiber posts covered with quartz fiber posts (Aestheti-Posts\textsuperscript{8}) 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 (Aestheti Plus Posts\textsuperscript{8}).

Different specific \textit{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,\textsuperscript{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, AEstheti Posts and AEstheti 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.\textsuperscript{22-24}

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

**Materials and Methods**

In the last 6 years, 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 AEstheti Posts were also placed and finally, after January 1998, AEstheti 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.\textsuperscript{25} Actuarial Life Table statistical analysis and Mantel-Haenszel comparison of survival curve were performed at 95% level of confidence. A total of 719 patients treated with 850 C-Posts, 215 patients with 249 AEstheti Posts and 234 patients with 290 AEstheti Plus Posts were selected for evaluation. The age of the patients ranged from 20-84 yrs (mean 53 yrs).

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.\textsuperscript{b} After no less than 48 hours from the endodontic treatment the roots were prepared for receiving a post. In the molar roots only 1 post was placed, in the palatal root of maxillary and in distal root of mandibular teeth.

After selection of appropriate drill size, the root canal space was prepared using preshaping and finishing drills\textsuperscript{q} 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\textsuperscript{a} and One-Step\textsuperscript{a} in combination with C \& B\textsuperscript{c} resin cement, Scotchbond Multi-Purpose Plus\textsuperscript{c} in combination with Opal\textsuperscript{d} luting composite and Scotchbond 1\textsuperscript{c} with Rely X\textsuperscript{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\textsuperscript{a} self-curing RBC was mainly used on C-Posts and AEstheti Posts while AEeliteflow light-curing RBC was used for build-up abutment restored with AEstheti Plus Posts.

Table 1
Clinical distribution of posts.

<table>
<thead>
<tr>
<th></th>
<th>Incisors</th>
<th>Laterals</th>
<th>Canines</th>
<th>Premolars</th>
<th>Molars</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>C-Posts Maxillae</td>
<td>80</td>
<td>85</td>
<td>92</td>
<td>110</td>
<td>103</td>
<td>460</td>
</tr>
<tr>
<td>C-Posts Mandible</td>
<td>65</td>
<td>60</td>
<td>46</td>
<td>98</td>
<td>101</td>
<td>380</td>
</tr>
<tr>
<td>C-Posts Total</td>
<td>145</td>
<td>145</td>
<td>138</td>
<td>208</td>
<td>204</td>
<td>840</td>
</tr>
<tr>
<td>AEstheti Posts Maxillae</td>
<td>25</td>
<td>26</td>
<td>15</td>
<td>21</td>
<td>28</td>
<td>109</td>
</tr>
<tr>
<td>AEstheti Posts Mandible</td>
<td>21</td>
<td>20</td>
<td>10</td>
<td>31</td>
<td>24</td>
<td>106</td>
</tr>
<tr>
<td>AEstheti Posts Total</td>
<td>46</td>
<td>46</td>
<td>25</td>
<td>52</td>
<td>52</td>
<td>215</td>
</tr>
<tr>
<td>AEstheti Plus Maxillae</td>
<td>34</td>
<td>30</td>
<td>20</td>
<td>26</td>
<td>30</td>
<td>130</td>
</tr>
<tr>
<td>AEstheti Plus Mandible</td>
<td>21</td>
<td>24</td>
<td>16</td>
<td>30</td>
<td>28</td>
<td>119</td>
</tr>
<tr>
<td>AEstheti Plus Total</td>
<td>55</td>
<td>54</td>
<td>36</td>
<td>56</td>
<td>58</td>
<td>249</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Types of Posts</th>
<th>Age interval in months (average)</th>
<th>n. of Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Composiposts</td>
<td>18-68 (46)</td>
<td>840</td>
</tr>
<tr>
<td>Aestheti Posts</td>
<td>12-18 (14)</td>
<td>215</td>
</tr>
<tr>
<td>Aestheti Plus</td>
<td>12-16 (13)</td>
<td>249</td>
</tr>
</tbody>
</table>
Parameters
The rate of success was assessed by clinical and intraoral radiographic examinations. Radiographs were taken of each fiber post with the long-cone technique and ultraspeed film. 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 dislodgement 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 8-68 (mean 46) months (Table 2). The AEstheti Posts remained in place for a period ranging between 12-18 (mean 14) months and the AEstheti 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 statistical significant difference among the four groups. No root fracture, dislodgment of post or of the crown was found.
The debonding failures were almost equally distributed among the 4 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.

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

<table>
<thead>
<tr>
<th>Fiber posts</th>
<th>Aestheti posts</th>
<th>Aestheti Plus</th>
<th>Total</th>
<th>Failures</th>
</tr>
</thead>
<tbody>
<tr>
<td>AB2</td>
<td>625 (11)</td>
<td>50 (2)</td>
<td>29 (1)</td>
<td>704</td>
</tr>
<tr>
<td>SBMPP</td>
<td>75 (7)</td>
<td>18 (1)</td>
<td>10 (5)</td>
<td>103</td>
</tr>
<tr>
<td>SB1</td>
<td>78 (2)</td>
<td>64 (2)</td>
<td>110 (5)</td>
<td>252</td>
</tr>
<tr>
<td>OS</td>
<td>62 (2)</td>
<td>83 (3)</td>
<td>100 (1)</td>
<td>245</td>
</tr>
<tr>
<td>Total</td>
<td>840 (22)</td>
<td>215 (8)</td>
<td>249 (11)</td>
<td>1304</td>
</tr>
</tbody>
</table>

25 posts failed because of debonding. All debonded posts were rebonded 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. Actuarial Life Table statistical analysis and Mantel-Haenszel comparison of survival curve have been performed at 95% level of confidence.

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\textsuperscript{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 that have this property.\textsuperscript{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.\textsuperscript{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.\textsuperscript{17} The fiber posts do not need any special surface pretreatment. While microretention may be created in the zirconium post-surface, the adhesion between the post and the resin cement was not uniform.\textsuperscript{17} Finally, in case of re-treatment, the carbon fiber and the experimental posts are easily removable by a drill,\textsuperscript{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 teeth endodontically failed teeth were then retreated and restored. The survival rate of the fiber posts was similar to that found in other retrospective studies\textsuperscript{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 an uncontrolled area where a fracture can start. Another reason for fracture can be that the cast post has retention due to friction 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. These finding agrees with Trabert et al.\textsuperscript{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\textsuperscript{11} technique. After removing the fiber post completely with drills, the endodontic therapy was performed and after 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.\textsuperscript{34,35}

The latest generation of adhesive systems provides acid etching to remove the smear layer and demineralized root dentin, so that a surface increase of dentin available for bonding is achieved and a fine network of collagen fibrils is exposed.\textsuperscript{34,35} 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.\textsuperscript{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.\textsuperscript{34-35}

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


