Placement of fiber prefabricated or custom made posts affects the 3-year survival of endodontically treated premolars

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ABSTRACT: Purpose: To assess whether the amount of residual coronal dentin and the placement of a prefabricated (DT Light Post)(LP) or a customized fiber post (Ever Stick Post)(ES) have a significant influence on the 3-year survival of endodontically treated premolars. Methods: A sample of 345 patients provided six groups of 60 premolars in need of endodontic treatment. Groups were defined based on the amount of dentin left at the coronal level after endodontic treatment and before abutment build-up. Within each group teeth were randomly divided into three subgroups (n=20). In Subgroup A, no root canal retention was provided for the coronal restoration. In Subgroups B and C, LP and ES, respectively, were placed inside the root canal. All the teeth were finally restored with a single unit metal-ceramic crown. Results: Data were not affected by any loss to follow-up. The overall 36-month survival rate of crowned endodontically treated premolars was 76.7%. The lowest survival rate was recorded for teeth restored without any root canal retention (62.5%). Teeth restored with LP had a survival rate higher (90.9%) than those restored with ES (76.7%). The Cox regression analysis showed that the presence of root canal retention was a significant factor for survival (P<0.05). The decrease in failure risk was higher in teeth restored with LP (HR= 0.1; 95% CI for HR= 0.09 to 0.34; P< 0.001) than when using ES (HR= 0.5; 95% CI for HR= 0.3 to 0.7; P= 0.003). Teeth retaining one (HR= 0.3; 95% CI for HR= 0.2 to 0.7; P= 0.003), two (HR= 0.2; 95% CI for HR= 0.1 to 0.5; P< 0.001), or three coronal walls (HR= 0.1; 95% CI for HR= 0.05 to 0.3; P< 0.001) had a significantly lower failure risk than teeth deprived even of the ferrule effect. Similar failure risks existed for teeth missing all the coronal walls regardless of the presence or absence of a ferrule effect (P> 0.05). Interaction terms were not significant (P> 0.05). Post placement and the amount of residual coronal dentin affected the 3-year survival of endodontically treated premolars. (Am J Dent 2008;21:179-184).

CLINICAL SIGNIFICANCE: To obtain the highest success rate, endodontically treated premolars should be restored with a fiber post and a complete crown. The “ferrule” structure has a direct influence on the clinical success rate.

Introduction

A new approach to the restoration of endodontically treated teeth has been prompted by the introduction of fiber-reinforced composite (FRC) posts. With an elastic behavior more closely resembling that of dentin, fiber posts have limited the occurrence of irreparable root fractures as compared with metallic posts. Moreover, higher fracture resistance and more favorable failure patterns were reported in vitro for teeth restored with FRC posts than in the absence of any root canal retention. The survival of treated teeth has been assessed in several retrospective and prospective clinical studies. Failure rates ranging from the 8% of carbon fiber posts over an 8-year observation period in a retrospective study, to the 12% of glass fiber posts in a 2-year prospective investigation have been recorded. Differences in study design, inclusion criteria, number of observed patients, and observation periods may have accounted for dissimilarities in the results. Variables such as tooth type and position within the dental arch in relation to the occlusal forces, the presence of proximal contacts, and the type of the final restoration has been found to have an effect on the longevity of root treated teeth. Additionally, the amount of coronal residual structure has been recognized as critical to the survival probability of pulpless teeth. In particular, the contribution to mechanical properties of preserving a 2 mm high dentin collar, the so-called “ferrule effect”, has been emphasized.

Recently, as an alternative to metallic and prefabricated fiber posts, FRC materials have been proposed for constructing custom made posts. The fiber bundles can be adapted directly into the post space, so as to obtain a customized post, which is then adhesively luted. Several in vitro studies have investigated the mechanical properties and indications of these FRC materials. However, no clinical study has so far assessed whether teeth restored with such custom-made posts have a significantly different clinical outcome in comparison with teeth restored with FRC prefabricated posts or without any root canal retention.

Therefore, the present study prospectively evaluated the 3-year clinical behavior of root-treated premolars with varying degrees of coronal tissue loss that were restored with DT Light Post’ posts, EverStick fibers or without any root canal retention. All the teeth were finally covered with a prosthetic crown. The tested null hypothesis was that neither the amount of residual coronal dentin nor the placement of a prefabricated or customized FRC post in the root canal significantly affected the 3-year survival of endodontically treated and crowned premolars.

Materials and Methods

A total of 345 patients who consecutively presented at a private dental office for receiving endodontic treatment and restoration of premolars provided six groups of 40 teeth each. No more than two teeth per patient were considered for the study. Informed written consent was obtained from the patients after they had received clear explanation of the purpose of the trial, according to a protocol preliminarily approved by the
Instrument the root canals with K-files (#08-10-15) and Flexmaster (#15-20-25-30-35-40 VDW), mounted on an electric handpiece (Endo IT professional), having established the working length at 1 mm above the radiographic apex.

In between instrumentations irrigate with 3 mL of 5.25% sodium hypochlorite using a long 27-gauge needle. Use deionized water as the final rinse, and maintain patency of the canal with a #10 K-file.

Condense the gutta-percha using the continuous wave technique up to 4 to 5 mm from the apex with a System B heat source 5 mm from the apex with a System B heat source. Use of thermoplastic gutta-percha and an Obtura II unit.

Filling of the root canal access with a glass-ionomer filling material (Fuji IX).

Subgroup B
Apply Caulk 34% Tooth Conditioner Gel to the post space. After 15 seconds, rinse with water. Remove the excess water with an air blast. With paper points remove the residual moisture without desiccating the etched dentin surface.

Subgroup C
Apply Bisco 37% phosphoric gel to the post space. After 15 seconds rinse with water. Remove the excess water with an air blast. With paper points remove the residual moisture without desiccating the etched dentin surface.

Institutional Review Board of the University of Siena, Italy. Patients’ ages ranged from 18-76 years, with an average of 58 years. The selected teeth needed to be in occlusal function with a natural tooth and in interproximal contact with two adjacent natural teeth. If the teeth had already been endodontically treated, the inclusion criteria of symptom-free root canal filling and a minimum apical seal of 4 mm, without any periapical lesion on the X-ray, had to be met by the tooth to be restored. Clinical procedures were performed by the same operator. Groups were defined as follows, based on the amount of dentin left at the coronal level after endodontic treatment and before abutment preparation:

Group 1. All the coronal walls were present (Fig. 1A);
Group 2. Three coronal walls were retained (Fig. 1B);
Group 3. Two coronal walls were preserved (Fig. 1C);
Group 4. Only one coronal wall was left intact (Fig. 1D);
Group 5. Ferrule effect: no coronal wall was retained, although a collar of dentin at least 2 mm in height, as measured with a periodontal probe, was preserved circumferentially;
Group 6. No ferrule effect: no coronal wall was retained, and less than 2 mm of dentin was present circumferentially.

Within each group three equally sized subgroups (n=20) were randomly formed:

Subgroup A. No root canal post was placed;
Subgroup B. Root canal post was placed.
Subgroup B. DT Light Posts were used to provide retention to the coronal restorations;
Subgroup C. EverStick fibers were adapted into the post space to obtain a customized FRC post.

For all the teeth the final restoration was a single unit metal-ceramic crown.

Clinical procedures - Tables 1 and 2 respectively summarize the procedures for root canal treatment and post luting.

In the teeth to be restored with a post (Subgroups B and C), at least 24 hours after endodontic treatment, the gutta-percha was removed with Gates Glidden drills for a length of 7-8 mm, leaving at least 4 mm of intact apical seal.

For the DT Light Posts, the size (1, 2, or 3) that best fit the dowel space was chosen. The post was tried-in and consequently shortened with a diamond bur.

Prime&Bond NT Dual Cure adhesive system was used in combination with the dual-cure resin cement Calibra following manufacturer’s instructions. The abutment portion was built up using XFlow flowable composite and CeramX microhybrid composite.

EverStick fiber bundles were adapted into the dowel space, cured, removed from the root as per manufacturer’s instructions. The custom-made posts were then adhesively luted with All Bond 2 and Bis-Core. Bis-Core was also used for abutment build-up. The crown preparation varied from a full chamfer with a bevel interproximally and lingually, to a feather finish, depending on the height and thickness of the remaining dentin. Single unit porcelain fused-to-metal crowns were fabricated.

Evaluation parameters - Patients were recalled after 1, 6, 12 and 24 months for clinical and radiographic examinations. Periapical radiographs were taken with modified parallel technique and Ultra-Speed films, and examined at x5 magnification. The following events were considered as failures: post debonding, post fracture, vertical or horizontal root fracture, failure of the core portion requiring a new coronal restoration, displacement of the crown, endodontic and periradicular conditions requiring endodontic retreatment. Evaluation of success or failure was independently performed by two examiners other than the operator.

Statistical analysis - For descriptive purposes, Kaplan-Meier plots were constructed by subgroup (Fig. 2A), and by subgroup within each group (Fig. 2B-F).

The Cox regression analysis was applied in order to assess the influence on failure rate of the type of restoration (no post/DT Light Post/EveryStick Post), the amount of residual coronal dentin, and the interaction between the two variables. The level of significance was set at P<0.05.

Results

Table 3 reports frequencies and percentages of the failures occurred over the 36-month observation period. Data were not affected by any loss to follow-up. The overall 36-month survival rate of crowned endodontically treated premolars was 76.7%. The lowest survival rate was recorded for teeth restored without any root canal retention (Subgroup A, 62.5%). Teeth restored with DT Light Posts (Subgroup B) had a 3-year survival rate higher (90.9%) than those restored with EverStick fibers (Subgroup C, 76.7%).

In the presence of a post, no root fracture or failure of the abutment portion was recorded; all the failure events were due to post debonding, and occurred in teeth that presented with a reduced amount of residual dentin, with one wall at the most remaining at the coronal level.

For the sample teeth restored without a post, 13 root fractures and 32 crown displacements were observed. When EveryStick fibers were used, dislodgement of the crown and root fractures were the reasons for failures. The majority of crown dislodgements and all the root fractures occurred in teeth where the remaining coronal structure before abutment build-up was reduced to one or two residual walls at the most. All the teeth that exhibited four walls at the end of endodontic treatment survived the 3 years of clinical service, regardless of the restorative procedure including or omitting the placement of a post (Table 2).

For all of the premolars that experienced post debonding, the post was luted again and the teeth were maintained in clinical service. As for the cases of failed endodontic treatment, all the teeth presented with asymptomatic periapical lesions. Endodontic retreatment was performed and the teeth were restored to clinical service. All the root fractures but three were fatal failures. Thus, in cases of no ferrule structure remained, through a periodontal surgery intervention (crown lengthening), fiber post insertion and placement of new crowns, it was possible to bring the tooth back to function. Conversely, all the other fractured roots had to be extracted.

The Cox regression analysis (limited to Groups 2-6), showed that with the exclusion of teeth retaining four intact walls, all survived related to the restorative procedure. The model showed that the presence of root canal retention was a significant factor for survival (P<0.05).

The decrease in failure risk was higher in teeth restored with prefabricated posts (hazard ratio, HR= 0.1; 95% CI for HR= 0.09-0.04).
Fig. 2. Kaplan-Meier plots by subgroup: (A) show that the survival probability is higher for posted restorations from the 6-month recall on. The gap between the two curves becomes larger as time progressed. Kaplan-Meier plots constructed for the groups defined as four, three, two, and one preserved coronal wall (B–F respectively) indicate that the probability of tooth failure is higher in the presence of a reduced portion of crown dentin. Also, post placement appears to contribute the more to survival probability the less is the amount of coronal structure retained, as the gap between the “post” and “no post” curves gets bigger as the degree of hard tissue gets higher. A. Representation of the all three main groups tested in the study. B. Representation of the three groups without any coronal residual ferrule structure. C. Representation of the three groups with ferrule residual structure. D. Representation of the three groups with one coronal residual wall. E. Representation of the three groups with two coronal residual walls. F. Representation of the three groups with three coronal residual walls.
to 0.34; P< 0.001) than when using customized posts (HR= 0.5; 95% CI for HR= 0.3 to 0.7; P= 0.003). Teeth retaining one (HR=0.3; 95% CI for HR= 0.2 to 0.7; P= 0.003), two (HR=0.2; 95% CI for HR= 0.1 to 0.5; P< 0.001), or three coronal walls (HR= 0.1; 95% CI for HR= 0.05 to 0.3; P< 0.001) had a significantly lower failure risk than teeth deprived even of the ferrule effect. Similar failure risks existed for teeth missing all the coronal walls regardless of the presence or absence of a ferrule effect (P> 0.05). Interaction terms were not significant (P> 0.05).

Discussion

Following the protocol of a previous 2-year prospective clinical trial, the study was designed to verify whether the degree of coronal tissue loss and the placement of a root canal post or a custom post had an influence on failure-free time of root treated teeth. To this purpose, a point was made of standardizing as much as possible other variables that can affect the clinical service, such as tooth type and function in the dental arch (only premolars with natural teeth as adjacent and antagonist elements), as well as type of the final restoration (single unit porcelain metal crowns).

The restorative procedure that yielded the greatest survival probability was the placement of the prefabricated fiber post (DT Light Post). Specifically with Light Posts, a reduced probability of crown dislodgement was noticed and the occurrence of root fractures was prevented over the 3-year observation period. Also, the fracture resistance of these posts stood the test of clinical service, as no such failure was reported. As a matter of fact, for this type of fiber post a relatively high fatigue resistance had previously been recorded in vitro, in comparison with other posts that also performed less satisfactorily clinically. Also Ever Stick fibers contributed to prolong the failure-free time of endodontically treated premolars, in comparison with teeth restored without any root canal retention. Nevertheless, the protective role of Ever Stick fibers was less effective than that of DT Light Posts, showing a higher percentage of failures.

A possible explanation for the more convincing clinical outcome of DT Light Posts may reside in the superior mechanical properties of this prefabricated post, Although Light Post and Ever Stick posts have never been directly compared before, in previous fatigue and fracture resistance studies Light Posts outperformed another prefabricated post (Parapost Fiber White), that, according to Fokkinga et al., exhibited a fracture behavior similar to EverStick fibers. To the improvement in mechanical properties of Light Posts, the manufacturing step of fiber pre-stressing may have contributed. This procedure, which is unique to this type of post, involves soaking in the resin fibers that are pre-stressed in tension. On the final cure of the resin, the tension in the fibers is released and, consequently, the resin surface is left under compression, enabling the post to favorably absorb tensile stress during function.

Concerning the role of residual coronal dentin, indications can be found in the literature that the survival of restored pulpless premolars is greatly affected by the amount of crown structure preserved. The present study’s findings are confirmatory in this regard. All failures such as post debonding and fractures of non-posted roots occurred with those having only one wall or less coronal structure. Particularly, the loss of any ferrule effect appeared to place the restored tooth under a statistically significant higher risk of failure than when one or more coronal walls were retained.

Moreover, Kaplan-Meier plots suggested the contribution of post placement to tooth survival to become more effective with time and with decreasing amounts of preserved crown structure (Fig. 2B). Nevertheless, between factor interactions were not significant according to the Cox model. An alternative explanation for this lack of significance may reside in the relatively low overall failure rate of restored root filled premolars. Collection of longer-term data is still being pursued with the expectation of further strengthening the evidence so far provided regarding the role of the ferrule. Also, the outcome of other tooth types should be evaluated under the same experimental conditions. The limitation of the present study to premolars only, although justified by the need for standardization, inevitably affects the external validity of the findings.

Concerning the failures of endodontic treatment, in all the cases they were accompanied by a loss of the seal due to crown dislodgement or post debonding, possibly leading to root canal reinfection.

In conclusion, over a 3-year observation period, the placement of prefabricated or customized posts was shown to provide a significant contribution to the survival of pulpless restored premolars. This contribution was more effective for DT Light Posts than for Ever Stick posts. Irrespective of the restorative procedure, preservation of at least one coronal wall significantly reduced the failure risk. Longer-term data are expected to further strengthen the evidence regarding the protective role of the dentin ferrule.

a. RTD, St Egreève, France.
b. Stick Tech Ltd, Turku, Finland.
c. Denstply Ltd, Kostanz, Germany.
d. Bisco, Schaumburg, IL, USA

e. Eastman Kodak Co., Rochester, NY, USA

f. Coltène/Whaledent Inc., Altstätten, Switzerland.

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