In the past 10 to 15 years, the method of reconstructing endodontically treated teeth by the use of fiber post and core systems has gained acceptance among clinicians. A well-known characteristic of fiber posts is a modulus of elasticity that is in accordance with dentin, resin cements, and resin core materials. Laboratory studies have shown that this feature results in beneficial properties, such as lower occurrence of root fractures. More importantly, fractures observed with fiber posts were most commonly of a nature allowing repair, unlike the ones seen with conventional cast posts.

In clinical trials, lower occurrence of root fractures was noticed in general, along with the high survival rate of fiber posts combined with full crowns. Recent data have confirmed the good clinical performance of endodontically treated teeth restored with fiber posts and direct composite restorations.

In terms of bond strength of fiber posts to root canal dentin, the best results in short-term laboratory investigations have been achieved with the etch-and-rinse systems in combination with dual-cured resin cements. However, etch-and-rinse systems are considered to be technique sen-
sitive, especially if the wet bonding method is followed, as with acetone-based systems. Moreover, root canal dentin is different in nature than coronal dentin, and in clinical situations, it is usually additionally altered by endodontic procedures which involve the use of different irrigants. The shape of the root canal itself is another factor that influences adhesive procedures. Tay et al have shown that C-factors in bonded root canals are fairly high, exhibiting a negative correlation with resin sealer thickness. In contrast, the volumetric shrinkage is reduced as the cement layer is reduced, which results in reduction of shrinkage stress (called also the S-factor). However, it was concluded that the complex interaction of C- and S-factors in root canals can result in highly unfavorable conditions when compared with indirect intracoronal restorations with a similar resin film thickness.32 In accordance with these findings, it has been demonstrated that stresses from polymerization shrinkage which occur in the dowel space complicate the formation of high-strength bonds when cementing endodontic posts with resin cements. Therefore, it may be questioned whether the favorable results obtained in previous laboratory studies can be repeated in everyday practice performed by clinicians with different levels of knowledge and experience.

The aim of this study was to evaluate the influence of the operator’s experience on the success/outcome of fiber post cementation using an etch-and-rinse acetone-based adhesive. The null hypothesis tested was that the efficacy of adhesive cementation of fiber posts to root canal dentin is not influenced by the operator.

MATERIALS AND METHODS

Fifteen anterior human teeth, recently extracted for periodontal reasons, were used in this study. They were stored in 0.5% chloramine-T until use. One trained operator performed the endodontic procedures and prepared the roots for the insertion and bonding of the posts. The crown portion of each tooth was removed by cutting with a diamond blade, under copious water cooling, perpendicular to the long axis of the tooth. The roots were endodontically instrumented at a working length of 1 mm from the apex to a #35 master apical file. A step-back technique was used with stainless-steel K-files (Union Broach; New York, NY, USA), Gates-Glidden drills #2 to #4 (Union Broach), and 2.5% sodium hypochlorite irrigation. The roots were obturated with thermoplasticized injectable gutta-percha (Obtura, Texceed; Costa Mesa, CA, USA) and a resin sealer (AH-Plus, Dentsply DeTrey; Konstanz, Germany). Then, part of this filling material was removed with burs, and the canal wall of each specimen was enlarged with low-speed post drills provided by the manufacturer, in order to create a 9-mm-deep post space, as measured from the cementoenamel junction on the buccal aspect of the tooth. At this point, the specimens were randomly divided into 3 groups of 5 teeth each and distributed to 3 operators with different levels of experience to perform the luting of the posts. None of the three operators were involved in the previous endodontic and post space preparation procedures.

Group 1: expert operator (EO). At the time of this investigation, the expert operator had been placing fiber posts routinely for 10 years and had placed at least 1000 posts.

Group 2: moderately experienced operator (ME). The second operator (postgraduate student) had placed approximately 200 fiber posts within 2 years of clinical experience.

Group 3: operator with a low level of experience (LE). The third operator was an undergraduate student that had placed approximately 10 fiber posts prior to the present investigation.

Post Cementation
In all three groups, Prime&Bond NT Dual Cure adhesive system was used (Dentsply Caulk; Milford, DE, USA) in combination with the dual-curing resin cement Calibra (Dentsply...
Preparation of Specimens for the Push-out Strength Test

The portion of each root that contained the bonded fiber post was sectioned into 5 to 6 1-mm-thick serial slices with the Isomet saw (Buehler; Lake Bluff, IL, USA) under water cooling. Five bonded roots were used for each group, resulting in 25 to 30 slices per group for push-out strength evaluation. The thickness of each slice was measured with a digital micrometer. The portion of each root that contained the bonded fiber post was not involved in the luting procedures.

RESULTS

The mean and standard deviation of push-out strength values for the three experimental groups are shown in Table 2. In Fig 1, the length of each box represents the range of the push-out strengths measured in three groups. The highest values of push-out strength were recorded in group 1 (expert operator), while the variability of the data was the lowest in group 2 (medium experience). The one-way ANOVA revealed that no statistically significant differences in push-out strengths existed among the three experimental groups. The significance level was set at α = 95%.

DISCUSSION

Prior to luting the posts, endodontic procedures and preparations of dowel spaces were performed by the operator that was afterwards not involved in the cementation procedures. In this way, differences between three operators could have been related only to their diverse abilities to handle the adhesive cementation of the posts in the root canals.

In order to determine the retentive strength of fiber posts, microtensile4,17,22 and push-out3,10,16 tests have been used.

Table 2  Push-out strength

<table>
<thead>
<tr>
<th>DT Light Post</th>
<th>Number of specimens</th>
<th>Push-out strength (MPa) mean [SD]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prime &amp; Bond NT</td>
<td>31</td>
<td>12.44 [3.63]^a</td>
</tr>
<tr>
<td>Calibra</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 1 (expert operator)</td>
<td>28</td>
<td>11.68 [2.64]^a</td>
</tr>
<tr>
<td>Group 3 (operator with low experience)</td>
<td>27</td>
<td>11.18 [3.12]^b</td>
</tr>
</tbody>
</table>

Same superscript letter indicates no significant difference.
In the present study, the thin-slice push-out strength test was performed, since it has been shown to be more reliable than the microtensile technique for measuring the retentive strength of fiber posts to root canal walls. No aging was performed prior to the push-out test, in order to simulate clinically relevant conditions of loading at the early stage of a restoration's lifetime. Moreover, if an adhesive restoration is placed coronally, it can be assumed that a fiber post luted in the root canal should not be exposed to degradation processes.

No studies that investigated bond strength of Calibra resin cement to root canal dentin have been published so far. However, push-out strength values recorded in this study were in accordance with those reported by Goracci et al. for other adhesive cements. From the results of this investigation, no influence of the operator on the retentive strength of luted fiber posts could be determined, which lead to the acceptance of the null hypothesis.

The possible variability in the outcome of bonding procedures that may be induced by the operator was investigated in several studies. Sano et al. and Miyazaki et al. showed that the clinical experience of the operator influences bond strength to coronal dentin. The operator-related variability was shown to be a more important consideration than the material when gap formation was observed in a study by Jacobsen et al. Peschke et al. investigated the consequences of misinterpreting manufacturers’ instructions. A significantly higher amount of marginal openings was seen in groups where one of the steps in the application procedure was performed incorrectly.

However, information on how the operator’s expertise can influence the success of a procedure of adhesive post cementation was missing in the literature. Since bonding to intraradicular dentin is generally considered to be more technique-sensitive than adhesion to coronal tissues, the fact that strength values in this study were not different regardless of the clinician’s level of experience could be viewed as highly beneficial from the clinical stand point. DT Light Post posts cemented with dual-curing resin cement had shown favorable results in terms of 2-year clinical survival. These posts also performed very well when in vitro fatigue resistance was assessed. Therefore, it would be reasonable to expect high survival rate and satisfactory clinical behavior of restorations placed with quartz fiber posts. On the other hand, clinical studies that investigated fiber posts reported that along with the general success of this treatment option, debonding of posts was occasionally noticed.

Mannocci et al. investigated resin-dentin interfaces in teeth that were restored in vivo with adhesively cemented carbon fiber posts. Teeth needed to be extracted after 6 months to 6 years of service, and the interfaces were then examined. Debonding of the adhesive from the resin-infiltrated dentin area and debonding of the composite cement from the adhesive were the most frequently observed failure modes and were observed in one-third of the examined interfaces. Two recently published studies questioned the thought that the retention of adhesively bonded fiber posts in root canals is purely the result of resin infiltration and micromechanical interlocking. Pirani et al. reported the universal occurrence of interfacial gaps along the hybrid layer surface or the post-cement interface, and speculated that the clinical success of adhesively cemented fiber posts may be explained predominantly by frictional retention. In a study by Goracci et al., it was shown that friction is the chief factor contributing to the retention of bonded fiber posts.

The present investigation is the first one in the literature that shows the absence of any influence of the operator’s experience on the adhesive procedure. The authors are aware that the specific choice of materials might have influenced the results. It is possible that with a different fiber post, different adhesive approach, and/or a different resin cement, the operator’s experience in adhesive cementation procedures could be crucial to the outcome in terms of post retention. Therefore, it would be of interest to acquire deeper and more detailed insight into the long-term clinical performance of fiber posts before directly applying the in vitro results to the clinical situation.

**CONCLUSION**

There was no statistically significant difference in the retention measured for fiber posts luted by operators with different levels of clinical experience. Under the parameters of this study and using the materials specified, the operator’s experience in luting fiber posts into root canals does not affect post retention in vitro.
REFERENCES


Clinical relevance: Retention of adhesively cemented fiber posts was not influenced by the operator’s level of experience.