Evaluation of a simplified fiber post removal system.

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Abstract

Introduction*:* This study investigated the influence of clinical experience in relation to the efficacy and effectiveness of removal of two different fiber posts. ***Methods****:* In total, 48 intact single-rooted teeth were treated endodontically and obturated. Then, 10-mm post spaces were prepared and fiber posts were luted; 24 #1 D.T. Light-Posts were used in group 1, and 24 #2 Hi-Rem Prosthetic Posts were used in group 2. A pull-out test (n = 8 per group) was performed using a universal testing machine to compare bond strength. Then, fiber post removal efficacy and efficiency were tested. Each group was divided in two subgroups (n = 8) according to operator experience. In group 1, fiber posts were removed with an ultrasonic handpiece using a #3 Start-X tip. In group 2, a size 25/0.04 ProFile was used to remove the central soft polymer macrofiber and a #2 Largo drill was used to remove the fiber post and luting cement remnants. Post removal times were recorded to evaluate efficacy. Weight change was determined and post space walls were analyzed microscopically to evaluate effectiveness. ***Results****:* Bond strength did not differ significantly (p = 0.7569) between post systems. *Post hoc* Tukey's tests indicated that removal time was affected significantly by operator experience in group 1 ($p < 0.001$), but not in group 2. Weight change was affected significantly by experience level in both groups. No difference in post space wall characteristics was observed between subgroups. ***Conclusion****:* The Hi-Rem post was easier to remove than the D.T Light-Post.

Introduction

The restoration of endodontically treated teeth can be complex because of extensive loss of dental structure (1,2). Intraradicular posts are commonly used to gain additional retention and adequate support when the remaining coronal tissue can no longer provide it (3). Metal-free fiber posts are now considered to be advantageous for improving the performance of restorations (4–7) because their physical properties are similar to those of dentin and they have improved esthetic properties (8). Several dentin bonding techniques have also been developed to ensure maximal adhesion of post systems (9). Some studies have examined the *in vivo* clinical efficacy of post-endodontic restorations supported by fiber posts (10,11).

Occasionally, a post must be removed to allow non-surgical endodontic retreatment because of the development or reappearance of periapical pathology (12,13). In such endodontic retreatment, a fiber post–supported restoration may influence the difficulty of reaching the root canal system and apex. Moreover, the improved bonding of the fiber post to the root canal space may cause additional problems for removal. To facilitate post removal with minimal loss of tooth structure and root damage, many authors have advocated the application of ultrasonic vibration to the post (14–16). However, one potential shortcoming of such ultrasonic treatment is the production of heat. A previous study (17) showed that the application of vibration energy for more than 15 s generated a large temperature rise at the root surface; even when higher temperatures are recorded at the post surface than at the root surface, this temperature increase could be dangerous to periodontal ligaments and alveolar bone.

To facilitate fiber post removal, a glass-fiber post with a soft blue polymer macrofiber along its longitudinal axis was recently introduced (Hi-Rem Post; Overfibers, Ferrara, Italy). The manufacturer claims that this fiber post can be removed readily and non-invasively, but no published study has evaluated this claim.

Thus, the purpose of this *in vitro* study was to evaluate the influence of clinical experience in relation to removal time and effectiveness using two different fiber posts. The null hypothesis was that clinical experience would not significantly influence fiber post removal.

Materials and Methods

Specimen preparation

In total, 48 extracted, intact, human single-rooted teeth with similar root lengths were selected for this study. After root surface debriding, the specimens were stored in 0.5% chloramine. Each tooth was sectioned at the cementoenamel junction, perpendicular to the long axis of the tooth, using a cylindrical diamond rotary cutting instrument (Intensiv 314, Ø ISO 014, 8.0-mm length; Intensiv, Grancia, Switzerland). Specimens were instrumented endodontically using #1, #2, and #3 PathFiles (Dentsply Maillefer, Ballaigues, Switzerland) and an S1-S2-F1-F2-F3 ProTaper file sequence (Dentsply Maillefer) to the working length to enlarge the apex to size 30 with a 0.09 taper. The working length was established under 10× magnification (Pro Magis; Carl Zeiss, Oberkochen, Germany) when the tip of the file became visible at the apical foramen. Irrigation was performed with 5% NaOCl (Niclor 5; Ogna, Muggiò, Italy) alternated with 10% EDTA (Tubuliclean; Ogna) using a 2-mL syringe and 25-gauge needle. Specimens were obturated with gutta-percha using a DownPak heat source (Hu-Friedy, Chicago, IL, USA) and endodontic sealer (Pulp Canal Sealer EWT; Kerr, Orange, CA, USA). Backfilling was performed with an Obtura III (Analytic Technologies, Redmond, WA, USA). After 24 h, a post space was prepared in each specimen to a depth of 10 mm from the sectioned surface using dedicated drills according to the manufacturer's instructions. After preparation, the post space was cleaned with a 0.2% chlorhexidine digluconate solution and dried with absorbent paper points. Two different fiber posts with 0.06 tapers were used: the #1 D.T. Light-Post (R.T.D., Saint Egreve, France) was used in group 1 (n = 24) and the #2 Hi-Rem Prosthetic Post (Overfibers) was used in group 2 (n = 24). A self-adhesive resin cement (Clearfil SA; Kuraray, Tokyo, Japan) was used. The root canal walls were rinsed with water using a

syringe and then dried gently with paper points. The cement was dispensed into a mixing pad using the double syringe provided by the manufacturer in a 1:1 base:catalyst ratio, and then placed into the canal using 20-gauge Accudose Needle Tubes (Centrix, Shelton, CT, USA). The posts were seated to full depth using finger pressure, and light polymerization was applied for 40 s using a light-emitting diode curing light (VALO; Ultradent, South Jordan, UT, USA) at 1400 mW/cm^2. The specimens were kept humid for 24 h at 37°C.

Pull-Out Test

After storage, eight specimens in each group were embedded in acrylic resin blocks, with use of a parallel meter to maintain parallelism between the posts and resin blocks. The pull-out test was performed parallel to the long axes of the post and tooth at a cross-head speed of 0.5 mm/min using a universal testing machine (Instron Machine I, model 10/D; MTS Sintech, Shakopee, MN, USA). The force required to dislodge each post was then recorded in newtons (N).

Post Removal

In total, 32 specimens were selected for fiber post removal. In each group, fiber posts were sectioned perpendicularly at the post–tooth interface. Each group of specimens was divided in two subgroups (n = 8) according to the operator who removed the post. An undergraduate fifth-year student from the University of Turin Dental School (subgroup A) and a dentist with more than 10 years of experience in endodontics from the Department of Endodontics at the University of Turin Dental School (subgroup B) were selected as operators. The method of fiber post system removal for this study was demonstrated to the student and dentist.

Fiber posts in group 1 were removed without water spray using an ultrasonic handpiece (EMS, Nyon, Switzerland) fitted with a #3 Start-X ultrasonic post removal tip (Dentsply Italy, Cusano Milanino, Italy) that was used to break the bonding interface and vibrate out the post. Fiber

posts in group 2 were removed according to the manufacturer's instructions. A size 25/0.04 ProFile (Dentsply Maillefer) was used to remove the central soft polymer macrofiber, and a #2 Largo drill (Dentsply Maillefer) was used to remove the remnants of the fiber post.

The effective working time (efficiency) for each fiber post removal (considering only the operative phase, when the operator was working effectively) was measured with an electronic chronograph (PM 665; Philips, Eindhoven, Holland), approximated to the first decimal place.

Removal effectiveness was evaluated using quantitative and qualitative methods. Specimen weights were quantified to the fourth decimal place using a high-precision balance (SBS-LW-200, Steinberg Systems, Charlottenburg, Germany) at two timepoints: after post space preparation (T1) and after fiber post removal (T2). Increasing weight reduction between T1 and T2 was considered to reflect increasing dentin removal during fiber post removal procedures. After post removal, the teeth were sectioned vertically with a low-speed diamond water saw to allow qualitative evaluation of the post removal procedure. Specimens were observed under an optical microscope (SMZ 140 N2GG, Motic, Wetzlar, Germany) at 40× magnification. Two blinded independent investigators assessed removal effectiveness according to the following scoring system (18): 1, only dentine can be seen after post removal; 2, only cement can be seen after post removal; 3, <25% of fibers or cement remain after post removal; 4, 25–50% of fibers or cement remain after post removal; and 5, >50% of fibers or cement remain after post removal.

Statistical Analyses

The normal distribution of the data was first determined using the Kolmogorov–Smirnov test. Differences in fiber post bond strength, removal time, and removal effectiveness between groups were then evaluated using analysis of variance. *Post hoc* Tukey's tests were used to

determine whether significant mean differences in removal time and effectiveness existed between groups.

Differences were considered statistically significant when $p < 0.05$. Data were analyzed using the SPSS software (ver. 18.0 for Windows; SPSS, Chicago, IL, USA).

Results

Mean bond strength values, with standard deviations, are presented in Table 1. Bond strength did not differ significantly between post systems ($p = 0.7569$).

Mean post removal times (in seconds) are presented in Table 2 and mean removal effectiveness values, obtained by quantitative and qualitative evaluations, are presented in Table 3. *Post hoc* Tukey's tests indicated that removal time was affected significantly by operator experience in group 1 ($p < 0.001$), but not in group 2. A significant correlation was also found between operator experience and the quantitative effectiveness of fiber post removal. The skilled operator was more effective than the unskilled operator in removing the RTD and Hi-Rem post systems. Qualitative evaluation yielded comparable values in both groups.

Removal time was significantly shorter for Hi-Rem posts than for RTD posts ($p < 0.0001$).

Discussion

In some cases, fiber posts must be removed to regain access to root canal spaces when endodontic treatment has failed due to periapical pathology and surgical treatment is not achievable, or when post systems fracture. In recent years, bonding techniques to radicular dentin have been developed to ensure maximal adhesion of the post (19,20) and thereby avoid debonding, the most common failure of post systems (21,22). However, this improved bonding of the fiber post to the canal space may also cause a problem with removal. In this study, two types of intraradicular post were used. In the first stage of this study, before comparing the removal procedures, the bond strengths of the fiber posts were measured to determine whether they were comparable. Adhesion

was evaluated through a pull-out test, which has been used in several studies to assess post retention (23,24). This bond strength evaluation methodology was selected because it is an efficient way to assess shear and tensile bond strengths simultaneously (25). The results showed almost identical bond strength, probably because the post sizes were comparable and the specimen selection and preparation procedures were the same in both groups. Thus, the efficacy and efficiency of fiber post removal techniques could reasonably be compared.

Ultrasonic instruments are commonly used for the removal of luted posts because of the reduced risk of root perforation and the minimal loss of tooth structure (14,26). A weight change analysis has been used in previous studies to evaluate the dentin removal efficacy of ultrasonic tips (27,28). In this study, the specimens were weighed after post space preparation and after fiber post removal, and weight loss was found to be directly correlated with excessive removal of radicular dentin. In all groups, dentin loss resulting in slight canal enlargement was recorded after fiber post removal, although the expertise level significantly influenced these results. The less-experienced operator removed more sound radicular dentin during fiber post removal than the skilled operator, probably due to less sensitivity and familiarity in handling ultrasonic devices or rotating instruments. In contrast, effectiveness was not operator dependent; all specimens generally showed clean dentin with restricted areas of adhesive cement. These data contrast with those obtained in some previous studies (13,18), where visual analysis of removal effectiveness generally showed the presence of cement or residual fibers on radicular dentin walls. These conflicting results could be related to the different ultrasonic tip used in this study, which was specially designed for fiber post removal, or the tested post, the structural features of which facilitate removal procedures. Thus, the null hypothesis was partially accepted because clinical experience did not influence the qualitative efficiency of fiber post removal procedures.

Hi-Rem posts generally required less time for removal by the skilled or less-skilled operator. The presence of a soft macrofiber in the center of the post, which can be removed with an endodontic NiTi rotating instrument, leads to disruption of the post structure in a centrifugal

direction. This procedure is extremely rapid, especially in comparison with the use of an ultrasonic device alone. The oscillatory movements of the ultrasonic tip are transferred to the fiber post to break the interface between the post and the radicular dentin, resulting in slow destruction of the post structure and the dislodgement of the post in a coronoapical direction.

In conclusion, operator experience seemed to influence only the weight change, and thus the quantity of sound dentin removed. Hi-Rem posts generally required less time for removal by the skilled or less-skilled operator. The results of this study indicate that the clinical procedure for Hi-Rem fiber post removal is extremely rapid, especially when compared with the use of an ultrasonic device alone.

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The authors deny any conflict of interest related to this study.

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