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The effect of various fiber reinforced composite post surface treatments on its bond strength to root canal dentin

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Abstract

Purpose: Evaluating the effect of various fiber reinforced composite (FRC) post surface treatments on its tensile bond strength to root canal dentin.
Materials and method: Forty extracted human maxillary central incisors were selected. The coronal portion of each tooth was sectioned 15 mm coronally from the root apex. All root canals were instrumented, obturated and the post spaces were prepared to a depth 10mm. The specimens were classified into four groups according to the surface treatment. Group1:- surface treatment with plasma (argon plasma), Group2:- surface treatment with air born- particle abrasion, Group3:- surface treatment with air born -particle abrasion and silane, Group4:- control group without any surface treatment. Two randomly selected posts from each group were examined by Scanning Electron Microscopy (SEM). Self adhesive cement was used for cementation of all posts. Specimens were subjected to thermal cycling for a total of 5,000 cycles between 5 °C and 55 °C, with a 30-second dwell time, 20 sec transfer time at each temperature. The tensile bond strength test was performed using a universal testing machine at a cross-head speed 0.5 mm/min until failure occurred. Posts were examined under stereomicroscope to detect the mode of failure. The data were collected, tabulated and statistically analyzed.
Results: The tensile bond strength of the luting agent to the post was significantly affected by surface treatment ($P < 0.05$). Plasma treated group showed the highest bond strength followed by air-born particle abrasion with silanization and air-born particle abrasion while the control group showed the lowest bond strength.
Conclusion: Both plasma surface treatment and air-born particle abrasion with silane application improved the bonding of fiber post to the resin cement. The effect of plasma treatment was predominant.

Keywords: Fiber post; Surface treatment; Air born abrasive particles; Silane; Plasma; Tensile bond strength

1. Introduction

Endodontically treated teeth may be damaged by decay, excessive wear or previous restorations which resulting in a lack of coronal tooth structure [1]. Posts

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are widely used for retaining the endodontically treated teeth when there is insufficient coronal tooth structure to retain a core for the definitive restoration [2].

Commercially available prefabricated posts were traditionally made of metal alloys, and their use were reported to have less retention, serious types of root fracture, compromised aesthetic, and have the risk of corrosion or allergic reactions [3]. The increasing demand for aesthetic posts has led to the development of metal-free posts, specifically usage of translucent (quartz or glass) fiber posts [4].

Selecting an appropriate adhesive and luting procedure for bonding posts to root dentin is another challenge. Sealing is expected to be strong due to recent improvements in the sealing ability of adhesive resin luting agents [5]. Resin cements increase the retention and tend to leak less than other cements and because of the relatively complicated, technique-sensitive and time consuming disadvantages, some researchers have shifted towards simplified application procedures, which led to the development of self-adhesive resins combining etching and resin infiltration [6].

Failure of restorations using fiber reinforced posts due to dislodgement of the posts occurs most frequently at the post-resin junction [7]. Several surface treatments of the fiber posts have been undertaken to overcome this problem such as mechanical treatment and chemical treatment, which result in surface microroughness, creating a mechanical interlock between the two surfaces, and/or exposure of the fiber by removal of the matrix, permitting silanization with a silane coupling agent (chemical treatment). Some of these treatments may cause detrimental effects on strength of the post when treatment is performed over a long period, such as etching with hydrofluoric acid or blasting with aluminum oxide particles [8].

So it was necessary to evaluate the effect of various FRC post surface treatments on its bond strength to root canal dentin.

2. Materials and methods

Forty single-rooted extracted human maxillary central incisors with fully developed apices, similar size and shape were selected for this study. There width were measured both buccolingually and mesiodistally in millimeters, allowing a maximum deviation of 10% from the determined mean [9]. The specimens were stored in 1%Thymol solution [10].

The coronal portion of each tooth was sectioned 15 mm coronally from the root apex using a diamond double-faced disc, in a slow-speed handpiece, cooled with air/water spray. The roots were embedded in self-curing acrylic resin blocks.

The roots were endodontically instrumented at a working length of 1 mm from the apex using a #40 master apical file.[1] A step-back technique was used with stainless-steel K-files[1] and obturated with gutta-percha cones[1] and resin sealer (AH-26)[1] using a lateral condensation technique. Then the gutta-percha was removed with special preparation drills, leaving a minimum 4—5 mm apical seal and creating a standard post space of 10 mm from the coronal surface corresponding to the conical Easy Post size #4[1] [3].

All posts were equally and randomly divided into four groups (n = 10 per group) according to surface treatment of the post as follows:-

- Group 1: Plasma surface treatment.
- Group 2: Surface treatment with air-born particle abrasion.
- Group 3: Surface treatment with air-born particle abrasion and silane coupling agent.
- Group 4: Control group without any treatment.

2.1. Plasma surface treatment

The posts were surface treated by dielectric barrier discharge (DBD).This plasma system using argon gas at atmospheric pressure. The DBD was generated between two parallel-plate electrodes (25.5 cm × 25.5 cm, gap: 5 mm) driven at a frequency of 50 Hz frequency and a voltage of 20 kV. A limiting resistance R = 250 kΩ is used to limit the discharge current. The cell was fed by gas via gas inlet where the gas fills the gap space and was exhausted through gas outlet; the gas was left to flow in the cell for about 5 min for sweeping any impurities in the gap space before any treatment. The treated posts were fixed at the lower (earthed) electrode where the upper surface of the sample is exposed to the plasma reactive species. For double face treatments, the samples were treated on the opposite side at the same discharge conditions. Samples were exposed to plasma for 6 min[2] [11]

2.2. Airborne-particle abrasion

The posts were surface treated by extra oral sandblasting device using 50 μm alumina particles at 2 MPa

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