



Intricate Estimation and Assessment of Surface Conditioning of Posts to improve Interfacial Adhesion in Post–core Restorations: An *in vitro* Study

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ABSTRACT

Introduction: Post and core restorations are routinely used for restoring grossly decayed tooth structures. Various chemical agents are known to affect the interfacial adhesions between the post and the core. Hence, we planned the present study to evaluate the effect of various post-surface treatments on the interfacial strength between the posts and composite materials that are used for building up the core portion.

Materials and methods: The present study included assessment of the effect of surface conditioning of posts on the interfacial adhesion in post–core restorations. A total of 80 clear post-tapers were included and were divided broadly into four study groups based on the type of chemical testing protocols used. Various chemical treatments included alkaline potassium permanganate, hydrogen peroxide, and phosphoric acid. The fourth group was the control group. The composite core material was used for building up the core. Testing of the tensile load was done on a universal testing machine. All the results were analyzed by the Statistical Package for the Social Sciences (SPSS) software.

Results: The highest bond strength was observed in the study group treated with alkaline potassium permanganate, while the lowest was observed in the control group followed by the hydrogen peroxide group. While comparing the mean bond strength in between various study groups, significant results were obtained.

Conclusion: Chemical treatment protocol significantly alters the mean bond strength of the post and core restoration.

Clinical significance: Potassium permanganate significantly increases the bond strength between the fiber post and core restoration.

Keywords: Adhesion, Chemical, Post and core.

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INTRODUCTION

Fiber posts are broadly utilized to hold a core for changeless rebuilding of root canal-treated teeth that do not have adequate coronal tooth material.¹ The aim of most of the *in vitro* researches has been focused on assessment of factors that might alter the retentive characteristic of a post and which may incorporate outline, length, width, and surface actions.² Chemical cooperation that structures the security between fiber post and core is not sufficiently adequate to withstand the occlusal stresses; however, surface pretreatment of fiber post is the normal strategy utilized to enhance the attachment property of the material.²⁻⁴ Confirmation of the bond at the post–core interfacial level occurs only due to the chemical interaction occurring in-between the surface of fiber post and composite material. A few surface medications have been proposed keeping in mind the end goal to expand the present bonding with fiber post.^{5,6} In the light of above-mentioned data, we planned the present study to evaluate the effect of various post-surface treatments on the interfacial strength between the posts and

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composite materials that are used for building up the core portion.

MATERIALS AND METHODS

The present study was conducted in the Department of Conservative Dentistry of the Maharana Pratap College of Dentistry & Research Centre and included assessment of the effect of surface conditioning of posts on the interfacial adhesion in post–core restorations. Ethical approval was taken from the Institutional Ethical Committee, and written consent was obtained after explaining in detail the entire research protocol. A total of 80 clear post-tapers (Dentmark Co.) were included in the present study. The standard size of posts used was fixed to be 2.5 mm. For testing the efficacy of posts, four different types of chemical testing protocols were used. All the samples were divided into four study groups with 20 samples in each group as shown in Table 1.

Etching procedure common to all the four study groups included:

- Immersion of the post in a conditioning agent (methyl pyrrolidone solution diluted in deionized water) for 180 seconds at 55°C.

In group I, the samples were then immersed in phosphoric acid solution for 300 seconds at room temperature followed by rinsing in deionized water. Etching of group II samples was done in alkaline potassium permanganate solution for 120 seconds at 75°C. Immersion of the fiber posts of group III was done in hydrogen peroxide for 10 minutes at room temperature followed by rinsing with deionized water. After carrying out the procedures in all the study groups, immersion of all the samples was done in sulfate neutralizer solution for 300 seconds at 45°C. Rinsing of all the samples was done in deionized water, after which all the samples were air-dried.

Cleaning of all the posts was done ultrasonically in deionized water for 10 minutes, followed by ethanol treatment and air drying. Application of monolayer of silane coupling agent was done to the surface of the post in all the study groups and the control group followed by air-drying for 1 minute.

The composite core material was used for building up the core. Placement of a rectangular plastic matrix slab was done around the post followed by extension of matrix

up to the cylindrical portion of the post. For building up the remaining core portion, the incremental technique was used. A uniform 2-mm increment of composite was taken followed by curing for 40 seconds. After the uniform filling of the polymerized composite, the matrix was then detached and removed. Following the above-mentioned procedure, we obtained a rectangular slab of resin composite, which was made around the fiber post. Bonding and mounting of each specimen were done to the acrylic block after storing it in distilled water for 1 day. This was followed by holding the frame in a holding device. We created uniformly thick slab keeping the post in the central position followed by composite build core on the either sides. Serial sectioning of all the slabs was done for obtaining 1-mm thick beams. Metal jig was used for securing each beam with cyanoacrylate adhesive followed by testing of tensile load on a universal testing machine. Mathematical formula as described previously in the literature by Schwartz and Robbins et al was used for calculating the interfacial strength.⁷ Tensile strength obtained after application of mathematical formula was expressed in terms of MPa. All the results were analyzed by the SPSS software version 21. Chi-squared and Student's t-test were used for the assessment of the level of significance. A p-value < 0.05 was considered as statistically significant.

Statistical Analysis and Results

A total of 80 specimens were analyzed in the present study and were divided broadly into four study groups as shown in Table 1. These groups were divided based on the type of chemical treatment done. Groups I, II, and III consisted of specimens treated with phosphoric acid, alkaline potassium permanganate, and hydrogen peroxide respectively. Group IV consisted of control group. All the composed data were compiled judiciously and subjected to fundamental statistical analysis with SPSS version 21 for Windows. Mean bond strengths in groups I and II were found to be 15.02 and 20.46 MPa respectively (Table 2). Among groups III and IV, mean bond strengths were found to be 17.22 and 10.82 respectively (Graph 1). Significant

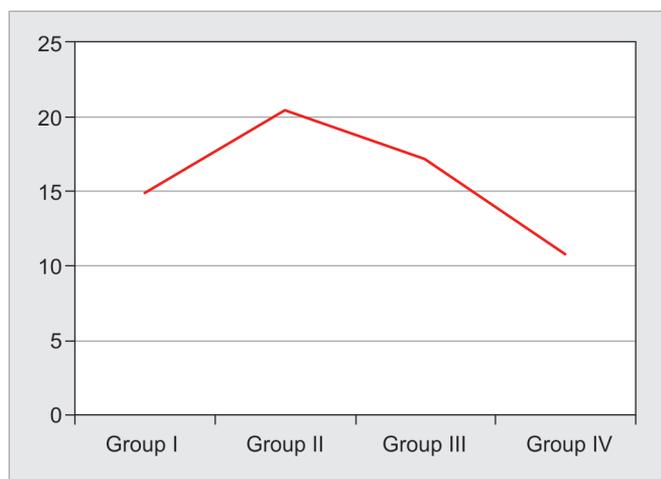
Table 1: Distribution of study samples in different groups

Group	n	Chemical treatment protocol
I	20	Etching with 37% phosphoric acid for 5 minutes
II	20	Etching with alkaline potassium permanganate for 10 minutes
III	20	Etching with 10% hydrogen peroxide for 10 minutes
IV	20	No chemical treatment (control group)

Table 2: Mean bond strength of samples in all the study groups

Group	Chemical treatment protocol	Mean bond strength (MPa)	p-value
I	Etching with 37% phosphoric acid for 5 minutes	15.02	0.02*
II	Etching with alkaline potassium permanganate for 10 minutes	20.46	
III	Etching with 10% hydrogen peroxide for 10 minutes	17.22	
IV	No chemical treatment (control group)	10.82	

*Significant



Graph 1: Descriptive value of mean bond strength of study samples in all the groups

results were obtained while comparing the mean bond strength in between various study groups ($p < 0.05$; Table 2). Highest bond strength was observed in the study group treated with alkaline potassium permanganate.

DISCUSSION

Selection of appropriate composite is a must for the success of post and core restoration. Along with this, quality of post–core interface also influences the clinical outcome of the restorations.^{8,9} Data of the past literature on the fiber-reinforced composite materials have led to the alteration of the qualities of the resinous matrix and the fiber's interface.^{10,11} Hence, we planned the present study to evaluate the effect of various post-surface treatments on the interfacial strength between the posts and composite materials that are used for building up the core portion.

In the present study, we divided all the samples into four study groups depending on the type of chemical treatment and protocol followed. In specimens etched with 37% phosphoric acid, mean bond strength was found to be 15.02 MPa (Table 1). Highest mean bond strength was found to be in specimens treated with alkaline potassium permanganate (Graph 1). Influence of various etching procedures on the tensile strength of the post and core interface was assessed by Monticelli et al.¹² They evaluated 60 DT light posts and divided them broadly into 10 study subgroups. Various chemical treatment protocols used were as follows: 10% hydrogen peroxide; 21% sodium ethoxide; potassium permanganate and HCl respectively. An interpenetrating adhesion network was observed on the scanning electron microscopic analysis between the surface of treated fiber post and the composite material in all the study groups. They observed a significant influence of potassium permanganate treatment on the interfacial strength of the post and core interface. Effect of various surface treatments on the tensile bond

strength of the dual-cured resin composite to fiber posts was assessed by Radovic et al.¹³ As per the pretreatment protocol used, they divided the study samples into two study groups. Group I consisted of samples in which sandblasting (Rocatec-Pre, 3M ESPE) was done, whereas group II consisted of specimens in which no pretreatment was done. Moreover, no significant binding was observed between dual-cured resin composite and fiber posts when posts were already surface treated (pretreated).

In the present study, we observed that chemical treatment protocol significantly affected the mean bond strength of the post and core restoration (Table 2). Interfacial tensile strength in-between the fiber post and core composite was assessed by Shori et al.¹⁴ They analyzed 20 fiber posts and broadly divided them into four study groups depending on the pretreatment protocol. Groups I and II comprised negative and positive control groups respectively. Groups III and IV comprised specimens pretreated with phosphoric acid and hydrogen peroxide respectively. They observed that 10% hydrogen peroxide had a significant effect on the tensile bond strength values out of all tested materials. Effect of hydrogen peroxide and methylene chloride on the shear bond strength of the interface of fiber post and composite resin core was evaluated by Yenisey and Kulunk.¹⁵ They analyzed a total of 24 posts, which were prepared with quartz and glass fiber post. Horizontal embedding of the posts was done in acrylic resin material. Placement was done in such a way that 50% of the post diameter was exposed. The 400-, 800-, and 1200-grit silicon carbide papers were used as successive grounding of the exposed surfaces respectively. This process ensured uniform smoothness. They divided all the specimens broadly into three study subgroups with eight specimens in each group, based on the type of surface pretreatment technique used. This also included the application of silane for 1 minute (S), etching with hydrogen peroxide for 20 minutes (H), and methylene chloride etching for 5 seconds (M). The S group consisted of the control group. Placement of a dual-polymerized composite resin was done in a polytetrafluoroethylene mold, which measured about 30 by 2 mm in dimension. Positioning of the resin was done on the post-specimen followed by polymerization for 20 seconds with polymerization unit. This was followed by storage of specimens in water at 37°C for 1 day. They used the universal testing machine for evaluating the shear bond strength of the posts and composite resins and expressed the values in terms of MPa. After analyzing the data with one-way ANOVA for measuring the shear bond strength, they observed a significant difference in between the two study groups. Soares et al.¹⁶ assessed the effect of airborne particle abrasion on the tensile bond strength of carbon/epoxy and glass/

bis-glycidyl methacrylate fiber-reinforced resin posts. They observed a significant difference on the post-type factor in between various study groups, for flexure strength and stiffness. From the results, they concluded that mechanical properties of the posts are not affected by airborne particle abrasion. However, after this pretreatment, they observed undesirable surface changes, which according to the authors, might alter and decrease the bond strength to resin cement.

CONCLUSION

Rational compilation of results and their correlations have clearly shown that mean bond strength of the post and core restoration is affected by the type of chemical treatment protocol followed. However, future studies with larger study groups are required for further exploration of this field of restorative dentistry, so as to establish certain concrete and authentic guidelines in this perspective.

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