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Comparative evaluation of Different Materials used to Treat Root Dentin Prior to use of Self-Adhesive Resin Cement for Post-Cementation–An in Vitro Study

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ABSTRACT

Aim: The aim of this study is to evaluate and compare different materials used to treat the root dentin prior to the use of self-adhesive resin cement for post cementation

Materials and methods: 30 extracted human single-rooted mandibular second premolars were selected for this study. The teeth were divided into 3 groups correspondingto the post space irrigation procedure and treated as follows: the saline solution group received 5 mL of saline solution; thephosphoric acid (PA) group treatment consisted of etching the walls with 35% orthophosphoric acid andthe NaOCl+ethylenediaminetetraacetic acid (EDTA)group was treated with 5 mL of 3% NaOCl, 5 mL of 17% EDTA, and 5 mL of distilled water. Fiber posts were attached with a self-adhesive resin cement, andspecimens were subjected for pull-out bond strength testing. The statistical evaluation consisted of 1-way ANOVA with the post hoc Tukey honest significant differences test.

Results: Group 1 (Root dentin treated with saline solution) showed statistically significant higher retention followed by Group 2 (Root dentin treated with 35% orthophosphoric acid). Group 3 (Root dentin treated with a combination of 3% NaOCl and 17% EDTA) showed the lowest retention among all studied groups which was statistically significant.

Conclusion: the results showed that when the root dentin of the prepared post space was treated with saline solution prior to the application of self-adhesive resin cement, it exhibited the maximum pull out bond strength when compared with the bond strength exhibited when root dentin was treated with phosphoric acid prior to application of self-adhesive resin cement followed by root dentin treated with a combination of NaOCl and EDTA prior to application of self-adhesive resin cement.

INTRODUCTION

As the number of teeth being retained by endodontic therapy is increasing day by day, there is a concomitant need for the dentist to have the knowledge and skills to restore them. The choice of restorative method is dependent upon the amount of supported coronal tooth structure that remains. Coronal tooth structure may be lost for a variety of reasons like caries, previous restorative treatment, traumatic injury, attrition, abrasion, erosion and resorption. The extent of destruction is an important determinant factor in deciding on the restorative materials and technique to be implied in restoring the tooth to its normal form and function. Endodontically treated teeth demand special restorative attention. Designing a restoration for any of those teeth depends primarily on the amount of remaining tooth structure. When more than half or almost all of the coronal tooth structure has been removed in an endodontically treated tooth it is rational to place a post attaching the root structure to a core material that is bonded to the remaining tooth structure.

The success of post system depends on the bonding performance of luting cement. Various luting agents have been proposed for bonding posts to root canal dentin used with self-etching or etch-and-rinse adhesive systems. In recent years, new resin cement formulas have been developed that have aself-adhesive capacity. These types of cement have the advantage to bond to anuntreated tooth surface that is neither micro-abraded nor pre-treated therefore, not requiring the application of any dentin adhesive system, thus once the cement is mixed, the application is accomplished in a single clinical step.[1]

They use an acidic primer which, without rinsing, can alter tooth structure before bonding; thus, simplifying the clinical steps than those with total-etch cements. Post space irrigation also influences the strength of the cement bond with the root dentin. While preparing the post space, a smear layer (consisting of gutta percha remnants and the root canal sealer) forms on canal walls, leading to increased leakage and obstruction of the dentinal tubules, thus blocking the adhesive luting of the fiber post. Therefore, various post space treatment strategies have been explored in order to preserve this resin–dentin adhesion. The purpose of root dentin treatment is basically the removal of smear layer, opening of dentinal tubules and exposure of collagen fibers to permit an adequate infiltration of the adhesive system and formation of a hybrid layer, producing a high bond strength. The purpose of this in vitro study was to compare the effects of different Post space irrigation procedures on the bond strength of fiber posts attached with self adhesive resin cement.

MATERIALS AND METHODS

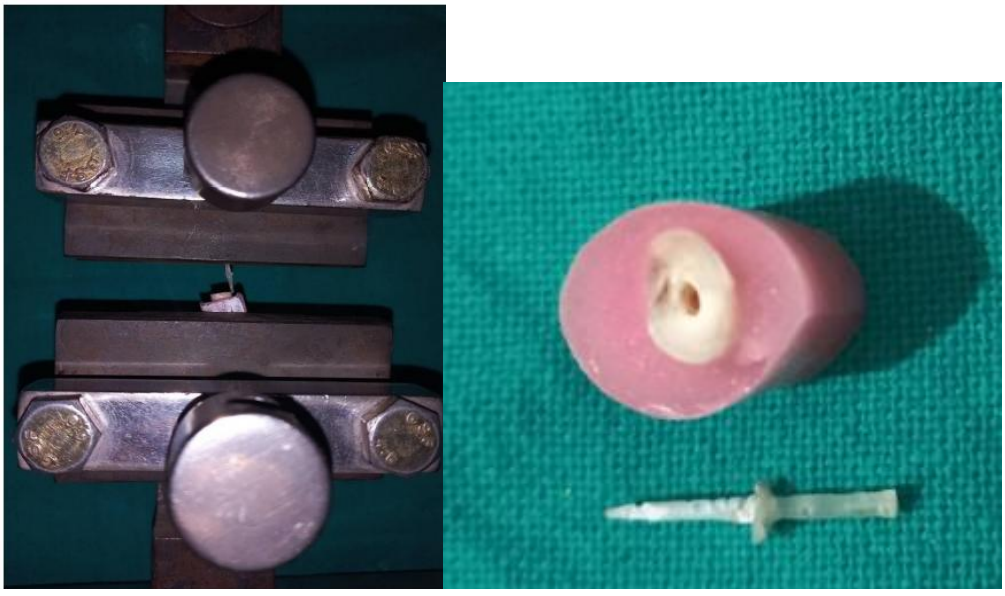
Thirtyextracted human single-rooted mandibular second premolars were selected for this study.Inclusion criteria were a single canal and absence of internal resorption (confirmed from buccolingual and mesiodistal radiographs), absence of caries, absence of root cracks.Teeth were maintained in distilled water and decoronated with a diamond disk (Isomet 2000; Buehler Ltd) below the cement and enamel junction. The working length was measured with a number 10 K-file. A rotary system (ProTaper gold) was used to apply the crown-down technique for the endodontic preparation procedure, and the apical preparation was extended with a file (ProTaper F3). The root canal was irrigated with 2 mL of 3% NaOCl between instrument changes and subsequently with 2 mL of 17% EDTA solution for 20 seconds was used to treat the root canal. Saline was used as the last irrigant to neutralize any residual chemicals present in the canal.The root canals were completely dried with absorbent paper after the final irrigation. The root canals were obturated with gutta percha points and a sealer.Samples were kept at 37° C in 100% humidity for 24 hrs to allow the sealer to set.

After the root canal treatment was completed, sequential reamers, with rubber stoppers, were inserted inside the canal and shaped using an in-out motion from size #1-3. Post space was prepared to leave at least 4mm of gutta-percha apically and prefabricated fiber posts of size 1.1mm diameter were selected.In between the use of each reamer, the post space was irrigated with saline. The post space was then dried using paper points and the teeth were randomly assigned to three groups according to the dentin pre-treatment protocol used:the saline solution group received 5 mL of saline solution for 1 minute; the phosphoric acid (PA) group treatment consisted of etching the walls with 35% orthophosphoric acidfor 15 seconds and then washed with 5mL of distilled water. and the NaOCl+ethylenediaminetetraacetic acid (EDTA) group was treated with 5 mL of 3% NaOCl and 5 mL of 17% EDTA each for 1 minute. Then they were irrigated with 5 mL of distilled water. After PSI, absorbent paper points were used to dry the root canals, and a SARC (RelyX U200; 3M ESPE) was applied to the root canal with a Lentulo spiral according to the manufacturer's instructions. Fiber posts were seated with slight finger pressure, and the SARC was polymerized.The specimens were embedded in auto polymerizing acrylic resin. Samples were stored in 100% humidity for 24 hrs until testing procedures were performed.

Samples prepared after post cementation

To evaluate the effect of different irrigating solutions on bond strength, the samples were subjected to a pull-out test parallel to the long axis of the post at a cross-head speed of 0.5 mm/min using a universal testing machine (Instron Co., Norwood, MA, USA). The force required to dislodge the fiber post was recorded in newtons. A 1-way ANOVA with a post hoc Tukey honest significant differences (HSD) test was used to evaluate statistical differences among the experimental groups

Samples placed for retention test



POST DISLODGED AFTER THE APPLICATION OF FORCE

RESULTS

All the data obtained was tabulated and subjected to statistical analysis. The data for the present study was entered in the Microsoft Excel 2007 and was analysed by using SPSS Statistical software version (22.0). The arithmetic mean and standard deviations were calculated for intra and intergroup comparisons. All the values were expressed in terms of mean±s.d. The one-way ANOVA and post hoc Tukey's test was applied to find the significant difference among the four groups.

When the mean values of different groups were compared, Group 1 (Root dentin treated with saline solution) showed statistically significant higher retention followed by Group 2 (Root dentin treated with 35% orthophosphoric acid). Group 3 (Root dentin treated with a combination of 3% NaOCl and 17% EDTA) showed the lowest retention among all studied groups which was statistically significant.

Table 1: Descriptive statistics of retention among various studied groups

Groups	N	Mean (In newton)	Std. Dev.	Std. Error
Group 1 (SALINE)	10	98.2	2.7406	0.8667
Group 2 (PHOSPHORIC ACID)	10	89	2.708	0.8563
Group 3 (NaOCl+EDTA)	10	62.1	2.5144	0.7951

(A) BAR REPRESENTATION

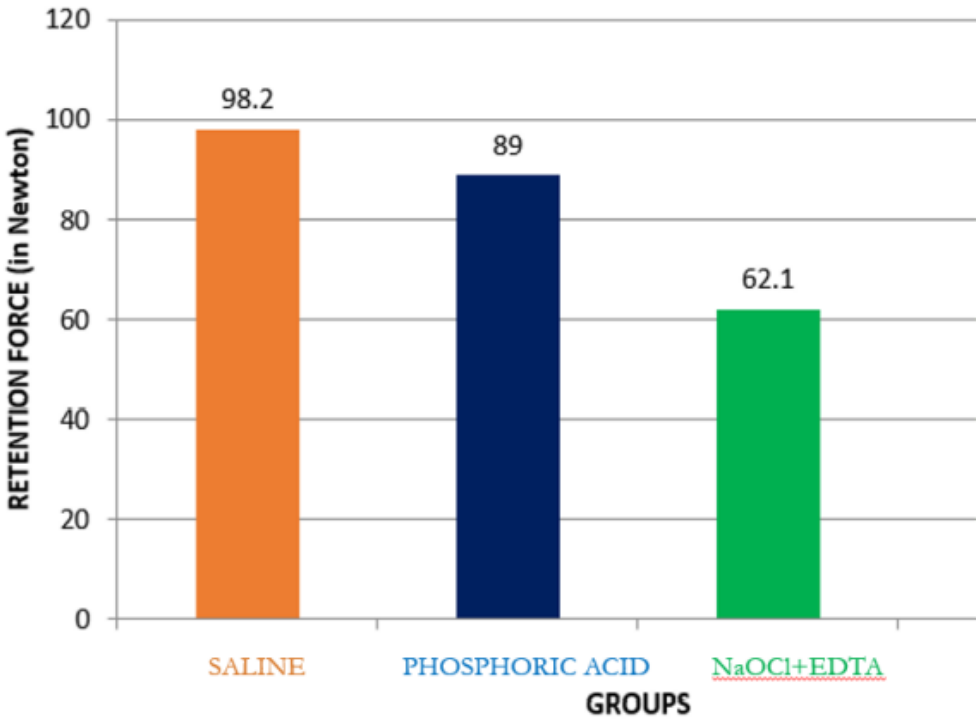


Table 2: Multiple group comparison of retention among various studied groups

INTERGROUP COMPARISON	MEAN DIFFERENCE	STD. ERROR	P value	Significant
Group I vs Group II	9.200	1.303	0.001	Significant
Group I vs Group III	36.100	1.303	0.001	Significant
Group II vs Group III	26.900	1.303	0.001	Significant

Statistically Significant

DISCUSSION

The role of different PSI procedures in determining fiber post-bond strength after the use of a SARC was evaluated. Results demonstrated that different irrigation procedures affect fiber post bond strength.

The process of cleaning and shaping of canals during root canal therapy causes the formation of a smear layer over the instrumented dentin. Different irrigants and agents are used for the removal of the smear layer that contains microorganisms and infectious deteriorated dentin. This step is required for a successful prognosis of root canal therapy. After the completion of endodontic treatment, if resin cements are used for cementing posts, removal of the sealer-impregnated dentin is highly recommended in order to reach fresh dentin and make a hybrid layer.[2] Acid-etching removes the smear layer, while acidic primers or acidic self-adhesive systems dissolve the smear layer and incorporate it into the hybrid layer. Research shows that different factors might affect the ability of an adhesive system to penetrate the smear layer and reach intact dentin, including the thickness of the smear layer and the acidity of self-adhesive systems.[3]

Some studies have indicated that retaining the smear layer on the dentin could interfere with the adhesion of self-adhesive materials because it may hinder the adaptation and bonding of the resinous material to the walls of the root canal.[4] Others have indicated the retention of the hybrid layer because some solutions used to remove it could modify the structure of the dentin, increase water flow, and compromise the bonding with the resinous monomers by interfering with the polymerization.[5]

Post-space irrigation (PSI) may influence the strength of the cement bond with the root canal dentin. Irrigating post spaces with chemical irrigants could remove the smear layer and increase the bond strength to radicular dentin. However, the results dependon the type of treatment, the duration of application, the radicular region, and the type of the adhesive system.[6]

The present study evaluated the effects of different post space irrigation protocols on the bond strength of a self-adhesive resin cement to the root canal dentin. The results showed that root dentin treated with saline solution exhibited the maximum pull out bond strength when compared with that of root dentin treatment with phosphoric acid followed by root dentin treated with a combination of NaOCl and EDTA.This can be due to the reason that after irrigating the root canal with any endodontic irrigant solution, chemical residues will diffuse along the dentinal tubules then affect the penetration of resin or inhibit the polymerization process of resin cement.

These findings were backed up by a study conducted by Ari H et al.[7]Rasimick BJ et al. conducted a study which indicated the retention of smear layer because some solutions used to remove it could modify the structure of the dentin, increase water flow and compromise the bonding with the resinous monomers by interfering with the polymerization.[5]In the present study, the mean bond strength of NaOCl and EDTA combination group was lowest than that of other groups. The reduction of the bond strength can be due to the change of the redox potential of the bonding substrate due to oxygen release from residual NaOCl. NaOCl is a nonspecific oxidizing agent.[8]The long duration of application and a high concentration of NaOCl could result in incomplete polymerization of resin cements, which compromises the bond strength and decreases the elastic modulus and the flexural strength of human dentin.[8]

The positive effect of irrigation with EDTA could be attributed to the ability of EDTA to remove the smear layer.[9] However, in the study by Hayashi et al.[10], irrigation with EDTA lowered the shear bond strength to dentin.They concluded that it may have been difficult to construct a firm adhesive interface between the resin cement and such demineralized radicular dentin.[10]

The application of orthophosphoric acid can effectively remove the smear layer on root canals. However, this acid produces slightly eroded surfaces with completely open dentin tubules. Conditioning of the dentin surface with acids dissolves the residual canal sealer, along with the microscopic remnants. Acids also open the dentinal tubules by removal of the smear layer and the smear plugs. They also demineralize the intertubular and peritubular dentin. Similar findings were backed by a study by Leirskar J and Nordbo H.[9]

Self-adhesive resin cements are dual-cured, based on filled polymers designed to adhere to tooth structure without the requirement of a separate etching step and application of an adhesive/bonding agent.Pereira et al.[11] found that the bond strength of fiber posts to root dentin varies depending on the cement used for post cementation, gap-free interfaces produce high interfacial strength, and the post level did not influence the bond strength of fiber posts to root dentin. The retention of fiber posts is dependent on the firm and lasting adhesion between resin cement and the dentin. In the present study, self-adhesive resin cement was used for luting of posts of all the four groups and showed good retention values.

CONCLUSION

Within the limitations of this study, it can be concluded that when the root dentin of the prepared post space was treated with saline solution prior to application of self-adhesive resin cement, it exhibited the maximum pull out bond strength when compared with the bond strength exhibited when root dentin was treated with phosphoric acid prior to application of self-adhesive resin cement followed by root dentin treated with a combination of NaOCl and EDTA prior to application of self-adhesive resin cement.

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