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A Comparative Evaluation Of Pushout Bond Strength Of A Glass Fiber Post To Root Dentin Pretreated With 6.5% Proanthocyanidin, 5% Glutaraldehyde And 10% Sodium Ascorbate: An In Vitro Study.

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Abstract
Objectives: *Aim of this in-vitro study was to evaluate the pushout bond strength of a glass fiber post to dentin pretreated with 6.5% proanthocyanidine, 5% glutaraldehyde and 10% sodium ascorbate.*
Materials and Methods: *Thirty-two single rooted human premolar teeth, extracted for orthodontic or periodontal reasons were decoronated at cementoenamel junction to a length of 14 mm. Root canals were prepared using rotary NiTi files and obturated with gutta percha and resin sealer. Post space was prepared using peeso reamers, retaining 5 mm gutta percha at apex. The smear layer was removed using 5 ml of 17% EDTA and the post space was etched with 37% phosphoric acid. The samples were randomly assigned to four groups (n=8) based on the pretreatment of root canal dentine: Group 1: Control (No Pretreatment), Group 2: 6.5% Proanthocyanidin, Group 3: 5% Glutaraldehyde and Group 4: 10% Sodium Ascorbate. A glass fiber post was luted using a dual cure adhesive and luting cement. 1 mm thick root slices were sectioned from coronal, middle and apical levels. The immediate (24 hrs) and delayed by aging the specimen with 10% sodium hypochlorite (6 months) push-out bond strength of the glass fibre post to the root dentine were measured using a universal testing machine at a crosshead speed of 0.5 mm/min until the fibre post dislodged.*
Statistical analysis: *Data was analyzed using One-way ANOVA Test & Post-hoc Tukey`s test (P<0.05).*
Results: *There was significant difference in the groups containing 6.5% Proanthocyanidin, 5% Glutaraldehyde and 10% Sodium ascorbate; where 10% Sodium ascorbate shows significantly higher immediate (24 hours) and delayed (6 months) pushout bond strength followed by 6.5% Proanthocyanidin (PAC) and 5% Glutaraldehyde.*
Conclusion: *Among the experimental group, 10% Sodium Ascorbate showed higher immediate as well as delayed pushout bond strength followed by 6.5% Proanthocyanidin and 5% Glutaraldehyde.*
Keywords: *pushout bond strength, glass fiber post, sodium ascorbate, proanthocyanidin, glutaraldehyde.*

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I. Introduction

An impact of long-term prognosis of endodontically treated teeth (ETT) can be functionalised using direct or indirect restorations. Endodontically treated teeth have little remaining structure, hence, an intracanal post is preferred by the clinicians to achieve anchorage for the final restoration (1). Hence, long-term retention of the post becomes pivotal for the stability and retention of the final restorations of ETT (2).

The minimal preparation needed for fiber post allows preservation of remaining dentin. Fibers aligned in the longitudinal direction of the posts result in less stress transmission to the resin matrix (3). Among the commercially available fibre posts, glass fibre posts are most commonly used for the restoration of ETT. These posts have the advantage of possessing an elastic modulus near to that of human root dentine, enabling uniform distribution of stresses along the post-cement-dentine interface and to the remaining tooth structure, thereby reducing the risk of vertical root fracture (4).

The post is luted to the root canal using resin cement in combination with a total-etch or self-etch bonding system (5). Resin-dentine adhesion is a technique sensitive procedure. The hydrolytic deterioration of resinous components and the host-derived enzymatic degradation of collagen fibrils together leads to loss of integrity of resin-dentine bonds over time (1). The stability of dentin collagen within the hybrid layer can be improved by inhibiting enzymatic degradation or by augmenting the collagen structure of dentine by treating it with natural or synthetic crosslinking agents (6). Proanthocyanidin (PACs), a natural collagen cross-linker, available in fruits and nuts have shown to improve the biomechanical properties and biostability of the demineralized dentine matrix by stimulating interfibrillar, intrafibrillar, and inter-microfibrillar cross-links in the collagen matrix (7,8). Glutaraldehyde is predominantly used as a fixative that cross-links collagenous biomaterials. Glutaraldehyde contains two aldehyde groups which react with amino groups of lysyl or hydrolysyl polypeptide residues in collagen, forming reducible Schiff-base crosslinks. Its ability to resist biodegradation in collagen molecules and produce irreversible cross-links help to keep the network in relatively expanded state (16). Sodium ascorbate is a mineral salt of ascorbic acid (vitamin C). It is used as an antioxidant and an acidity regulator. The major action of the sodium ascorbate is in the stabilization of the collagen, as a cofactor of hydroxylation of proline and lysine (17).

There are no studies evaluating the effect of dentin pretreatment with proanthocyanidin, glutaraldehyde and sodium ascorbate on the push-out bond strength of glass fibre posts to dentin. Hence, this in vitro study comparatively evaluated the pushout bond strength of glass fibre posts bonded to root dentin pretreated with 6.5% proanthocyanidin, 5% glutaraldehyde and 10% sodium ascorbate. The null hypothesis was that dentin pretreatment with PAC, glutaraldehyde or sodium ascorbate will not influence the bond strength of fibre posts to dentine.

II. Materials And Methods

Preparation of 6.5% PAC solution

6.5 g of grape seed-derived PAC powder (HealthyHey foods LLP, Mumbai, India) was weighed using a digital weighing balance and dissolved in 100 mL of distilled water to make a 6.5% PAC solution.

Sample preparation

Thirty-two single rooted human teeth, extracted for orthodontic or periodontal reasons, were collected and stored in 0.1% thymol solution. Teeth selected for study were decoronated at cementoenamel junction to get the standardised root length of 14 mm using a diamond disc under water coolant. A size10 K-file (Mani, Inc., Tochigi, Japan) was used to establish working length 1 mm short of the apex. Cleaning and shaping were done at the working length using rotary NiTi files (Neoendo S files) following the sequence S1, S2, F1, F2 and F3. Canals were then irrigated using 5 mL of 3% sodium hypochlorite (NaOCl) between each change of instrument. Following instrumentation, the smear layer was removed using 5 mL of 17% EDTA. Finally, the canal was irrigated with 5 mL of 3% of NaOCl. Obturation using F3 gutta-percha cones (Dentsply Maillefer, Ballaigues, Switzerland) and AH plus sealer (Dentsply, Konstanz, Germany) was completed. Post space preparation was created with up to #3 peeso reamer, retaining the apical 5 mm of gutta-percha. The smear layer was removed using 5 ml of 17% EDTA and the post space was etched with 37% phosphoric acid. The etchant was rinsed off with water and the excess water was dried with paper points. The specimens were randomly assigned to four groups (n=8) based on the pretreatment of root canal dentine:

Group 1: Control (No Pretreatment)
Group 2: 6.5% Proanthocyanidin
Group 3: 5% Glutaraldehyde

Group 4: 10% Sodium Ascorbate

Samples in the control group did not receive any pretreatment and those in 6.5% proanthocyanidin group, 5% glutaraldehyde group and 10% sodium ascorbate group were irrigated with 5 ml of respective experimental solutions using 23-gauge needle. The solution was left in place for 5 min, with intermittent agitation using a microbrush. At the end of the exposure time, the solutions were rinsed off and the canals were dried with paper points. In all the groups, dual curing adhesive was applied using a microbrush and light cured for 20 seconds. Simultaneously, the glass fibre post was silianised and luted using a dual-cure resin cement and light cured for 30 seconds. The samples were later stored in distilled water for 24 hours.

Push out bond strength testing

Horizontal sections were made at the coronal, middle and apical levels of the post space using a diamond disc under water coolant to obtain 1 mm thick slices. Immediate push-out bond strength of glass fibre post to the root dentine of half of the samples from each group was measured using a universal testing machine at a crosshead speed of 0.5 mm/min until the fibre post dislodged from the specimen. Accelerated aging for 3 hrs with NaOCl half of the samples were done to obtain the delayed pushout bond strength. The average of push-out bond strength values as the mean push-out bond strength value of the specimen at the given root level.

Statistical analysis

Data were collected by using a structure proforma. Data were entered in MS excel sheet and analyzed by using Statistical Package for the Social Sciences (SPSS) software. Quantitative data were expressed in terms of Mean and Standard deviation. Association between two quantitative variables were seen by using one way ANOVA test and Post-hoc Tukey`s Test. A p value of <0.05 were considered as statistically significant whereas p value <0.001 were considered as highly significant.

III. Results

The mean and standard deviation of immediate (24 hrs) and delayed (6 months) pushout bond strength of all groups at three different levels of post space is given in Table 1. The results showed that there was significant difference (p < 0.05) in the groups containing 6.5% Proanthocyanidin, 5% Glutaraldehyde and 10% Sodium Ascorbate; where 10% Sodium Ascorbate showed significantly higher immediate as well as delayed pushout bond strength followed by 6.5% Proanthocyanidin (PAC) and 5% Glutaraldehyde. The push-out bond strength of samples in control group was the least. Intergroup comparisons revealed that the coronal third, showed significantly higher push-out bond strength than the middle and apical thirds with no significant difference.

Table 1: Mean ± standard deviation of the push out bond strength (MPa) of all the groups at different levels of the post space

Sr. no.	Groups	Immediate bond strength			After Aging bond strength		
		Coronal	Middle	Apical	Coronal	Middle	Apical
1	**Control**	8.15±2.46	9.25±2.87	8.12±2.36	7.53±1.96	8.11±2.32	7.35±1.91
2	**Proanthocyanidin**	20.31±5.42	18.26±5.34	17.68±4.8	18.49±5.36	16.69±4.36	15.81±3.61
3	**Glutaraldehyde**	15.29±3.28	13.59±3.04	11.47±4.43	13.06±3.16	11.43±4.40	10.86±2.98
4	**Sodium ascorbate**	23.65±6.45	21.86±5.92	19.37±5.44	20.54±5.63	19.18±5.08	17.31±4.68

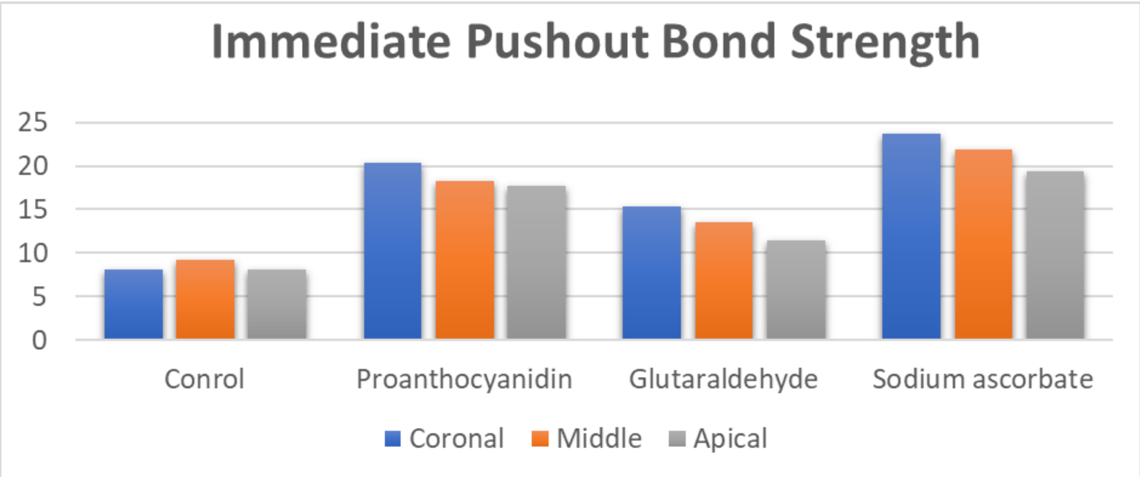

Fig 1: Immediate pushout bond strength of control, proanthocyanidin, glutaraldehyde and sodium ascorbate at coronal, middle and apical third level of post space

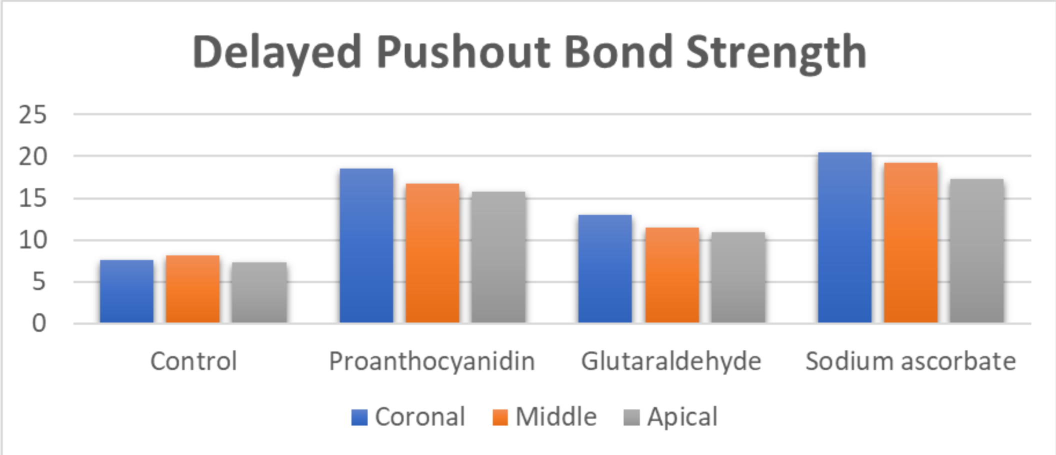

Fig 2: Delayed pushout bond strength of control, proanthocyanidin, glutaraldehyde and sodium ascorbate at coronal, middle and apical third level of post space

IV. Discussion

A successful coronal restoration is an important factor for endodontically treated teeth. The post-endodontic restoration depends on the integrity of the interface that the luting cement forms with the root dentin and the post (1, 5). Resin luting cements bond chemically with both the post and the resin composite core and micromechanically with the dentin, which results in a functionally and mechanically homogenous unit (1, 9). The hybrid layer formed leads to loss of integrity between the resin-dentin bond (10, 11). Different strategies have aimed to improve the bond durability by applying various collagen cross-linkers as pretreatment before resin infiltration. To improve the stability of this interface for a successful adhesion, various natural cross-linking agents like tannic acid, genipin, ascorbic acid, glutaraldehyde and PACs have shown to crosslink collagen and resist enzymatic degradation by inactivating the action of matrix metalloproteinases (5, 12-14).

The results of the present study showed that 6.5% Proanthocyanidin, 5% Glutaraldehyde and 10% Sodium ascorbate improved immediate (24 hours) and delayed (6 months) pushout bond strength of fiber post to dentin when compared to control group. The immediate pushout bond strength of all the groups seen to be increased than the delayed pushout bond strength. This is due to the storage of specimens in 10% NaOCl for 3 hr at 37ºC. This solution directly attacks the exposed collagen fibrils that are present in the hybrid layer or demineralized dentin surface (15). 10% sodium ascorbate showed highest immediate and delayed pushout bond strength; this might be due its ability to stabilize collagen and promote collagen biosynthesis. It also restores the bond strength and has an inhibitory effect on dentin MMP-2 activity, which participates in resin-dentin hybrid layer degradation (17). Pretreatment with 6.5% Proanthocyanidin also showed improved immediate and delayed pushout bond strength because of its affinity towards proline-rich protein such as collagen. It forms an insoluble complex with carbohydrates and proteins and facilitate the enzyme proline hydroxylase activity that is essential for collagen biosynthesis. PAC has been shown to increase collagen synthesis and accelerate the conversion of soluble collagen to insoluble collagen during development (Han B et al 2003). It has been attributed that the cross linking between PAC and the collagen brought about by covalent-, ionic-, hydrogen bonding- or hydrophobic interactions between the two. The amino acid proline in collagen is a good hydrogen acceptor and ensures a strong hydrogen bond with PAC (18). Thus, the PAC-collagen complex is stabilised predominantly by hydrogen bonding between the protein amide carbonyl and the phenolic hydroxyl groups of polyphenols in addition to covalent and hydrophobic bonds (17).

This study has put forth the role of different cross-linking agents on radicular dentin. Bond stability of glass fiber posts to dentin could be compromised due to chemicals used during endodontic treatment or during adhesive cementation procedures. Sodium ascorbate could serve as a promising cross-linking agent in improving the adhesion of glass fibre posts to dentine along with PAC and glutaraldehyde.

V. Conclusion

Within the limitations of this in vitro study, it can be concluded that the use of 10% Sodium ascorbate, 6.5% Proanthocyanidin and 5% Glutaraldehyde as collagen cross-linkers, increased the bond strength of glass fiber post to root dentin when compared to control group. 10% Sodium Ascorbate showed higher immediate as well as delayed pushout bond strength followed by 6.5% Proanthocyanidin and 5% Glutaraldehyde.

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