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EFFECT OF ANTIOXIDANT ON PULL-OUT BOND STRENGTH OF FIBER POST BONDED WITH SELF-ADHESIVE RESIN LUTING CEMENT

Endodontics

Dr. Anam Husain* M.D.S Student, Department of Conservative Dentistry and Endodontics, Subharti Dental College & Hospital, Meerut, Swami Vivekanand Subharti University. *Corresponding Author

Dr. Sachin Gupta M.D.S., Professor, Department of Conservative Dentistry and Endodontics, Subharti Dental College & Hospital, Meerut, Swami Vivekanand Subharti University.

Dr. Vineeta Nikhil M.D.S., Dean Clinical Affairs, Director PG Studies and Head, Department of Conservative Dentistry and Endodontics, Subharti Dental College & Hospital, Meerut Swami Vivekanand Subharti University

Dr. Shikha Jaiswal M.D.S., Professor Department of Conservative Dentistry and Endodontics, Subharti Dental College & Hospital, Meerut, Swami Vivekanand Subharti University.

ABSTRACT

Aim- To evaluate the effect of antioxidant on pull-out bond strength of resin cement to dentin.

Material and Methods- Post spaces were prepared in endodontically treated roots and were divided into four groups: Group A: Saline+ PUI, Group B: 17% EDTA+ PUI+ Saline, Group C: 5% NaOCl+ PUI+ 17% EDTA+ PUI+ Saline, Group D: 5% NaOCl+ PUI+ 17% EDTA+ PUI+ Saline+ 10% Sodium ascorbate+ Saline. Silanized fiber posts were bonded using RelyX U200 Automix. Thereafter, each specimen was embedded into self-cure acrylic resin using teflon ring moulds (2"X5/6"). The pull out bond strength for each sample was evaluated using Universal testing machine (at a cross head speed of 1.0 mm/min) and the force at which the sample debonded was recorded in mega pascal (MPa).The values thus obtained were tabulated and put to statistical analysis using One-Way ANOVA F and Independent "t"- test.

Results- Highest pull-out bond strength was seen in Group A followed by Group D.

Conclusion- Use of sodium ascorbate resulted in reversal of compromised bond strength caused by NaOCl.

KEYWORDS

Antioxidant, Pull-Out Bond Strength, Self-adhesive Resin Luting Cement.

INTRODUCTION

Intraradicular posts are often required in endodontically treated teeth presenting with extensive loss of tooth structure due to caries, restorative procedures, fractures and endodontic access preparation. Glass fiber posts, having modulus of elasticity similar to dentin prevent catastrophic failures by providing uniform stress distribution. Good adhesive bond established by resin luting cement at interfaces with the post and the dentin is necessary for the success of fiber post and core assembly. There are various factors affecting bond strength of post to dentin which include dentin surface treatment, type of luting cement used and presence/ absence of smear layer on the dentin surface. Presence of the smear layer may hinder penetration and adaptation of adhesive resin cement inside dentinal tubules, thus affecting bond strength.[1] Irrigation of post space with NaOCl/ EDTA might be considered critical for the removal of smear layer in order to generate effective resin-dentin interface bond. NaOCl may exert a negative effect on bond strength of post to dentin due to presence of nascent oxygen. Sodium ascorbate and many other antioxidants have been used for reversal of deleterious effects caused by NaOCl on the root canal dentin. Use of self-adhesive resin luting cement for luting of posts reduces the steps in bonding and make it user friendly. Various authors[2,3] reported the bond strengths of self-adhesive resin cements to be satisfactory and comparable to other multistep resin cements. Evaluation of bond strength of Rely X U200 after post space irrigation with various irrigants has not been documented much, therefore present study was carried out to evaluate the effect of post space treatment on pull-out bond strength of RelyX U200 to dentin after treatment with NaOCl, EDTA and sodium ascorbate.

Self-adhesive resin cement RelyX U200 is based on phosphoric acid methacrylates which are thought to demineralize and infiltrate the tooth sub s trate resulting in micromechanical retention.

Hence the aim of this study was to evaluate the effect of sodium ascorbate on pull-out bond strength of self-adhesive resin cement to root dentin after irrigation of post space with NaOCl.

MATERIALS AND METHODS

Sixty mandibular premolar teeth extracted for orthodontic reasons with single canal were selected and stored in 0.5% Chloramine T solution (Hi-Media Labs, India). Teeth were decoronated near the cementoenamel junction to obtain a standardized root length of 14 mm. The specimens were instrumented by using ProTaper rotary system (Dentsply, Maillefer Ballaigues, Switzerland) at a working length of 0.5 mm from the apex till F3 rotary file. After each instrumentation, the canals were irrigated with 1 ml of 5% NaOCl (Prime Dental Products Pvt. Ltd, India). Final irrigation was done with 5 ml of 17% EDTA (CanaLarge, Ammdent, Noida, India) for 1 min followed by 5 ml normal saline and dried with corresponding paper points (Dentsply, Maillefer Ballaigues, Switzerland). Obturation was carried out with warm vertical compaction technique using AH Plus sealer (Dentsply, De Trey, Germany) leaving a canal space of 9 mm followed by sealing with Cavit (Ammdent, Saronno-Italia). The obturated samples were stored for 24 hours at 37°C and 100% humidity. Post spaces were prepared using peeso drills (Mani Inc, Japan) sequentially till No. 4 to accommodate the corresponding Reforpost Glass Fiber (Angelus, PR, Brazil). The fit of the post was verified radiographically. Thereafter the prepared samples were randomly distributed into four groups based on the treatment of post spaces:

GROUP A: 5 ml of saline along with PUI for 1 min.

GROUP B: 5 ml of 17% EDTA along with PUI for 1 min followed by rinsing with 5 ml of saline for 1 min.

GROUP C: 5 ml of 5% NaOCl for 1 min followed by 5 ml of 17% EDTA for 1 min along with PUI for both irrigants followed by 5 ml of saline for 1 min.

GROUP D: Samples of group D were treated similar to group C followed by irrigation with 10% sodium ascorbate solution (Now Foods, 395 S. Glen Ellyn Rd. Bloomingdale, IL 60108, USA) at the rate of 1 min per ml for 10 mins without PUI. The samples were then rinsed with 5ml of saline for 1 min.

Freshly mixed 10% sodium ascorbate solution was prepared by dissolving 10 gm of sodium a scorbate powder in 100 ml of distilled water.

Passive ultrasonic irrigation (PUI) with all the irrigants according to the desired protocol was performed in all the groups using No. 15 Mani U file (Mani Inc, Japan) followed by drying with Surgitip-endo (Roeko, Coltene, USA) and multiple paper points. Each fiber post (Reforpost, Angelus, Londrina, PR, Brazil) was cleaned with 70% alcohol and silanized with silane coupling agent (Silano, Angelus, Londrina, PR, Brazil). RelyX U200 Automix (3M ESPE, Seefeld, Germany) was directly placed into the post space and fiber post was seated into the post space followed by curing with LED light curing unit (Woodpecker, India) for 40 seconds from the coronal side. Thereafter, each specimen was embedded into self-cure acrylic resin using teflon ring moulds (2"X5/6"). The pull out bond strength of fibre post for each sample was evaluated using Universal testing machine (at a cross head speed of 1.0 mm/min) and the force at which the sample fractured was recorded in mega pascal (MPa).The values thus obtained were tabulated and put to statistical analysis. The failed samples were split longitudinally and examined under stereomicroscope (x20) along with fiber post to observe the pattern of bond failure.

Statistical Analysis

The comparison of distribution of average push-out bond strength was done using one-way ANOVA F with post hoc analysis using Independent "t"- test for multiple group comparisons. $P < 0.05$ were considered to be statistically significant. The entire data were analyzed statistically using Statistical Package for Social Sciences version 19.

RESULTS:

Mean pull-out bond strength values across four study groups can be arranged in descending order as: Group A (6.9 MPa) > Group D (6.3 MPa) > Group B (5 MPa) > Group C (2.9 Mpa).

Independent "t" test between different pair of groups suggested a statistically significant difference ($p<.05$) in the mean pull-out bond strength value of fiber posts among all the groups (Table 1). Stereomicroscopic analysis in all groups revealed a mixed pattern of failure of bond (Table 2) (Fig. 1, 2).

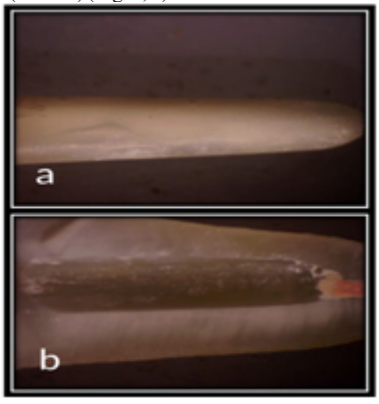

Fig. 1: Representative image of adhesive bond failure between fiber post (a) and luting cement (b) in Group B and Group C.

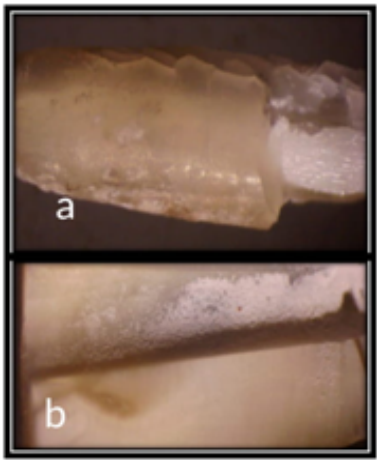

Fig. 2: Representative image of mixed failure between fiber post (a) and the self-adhesive resin luting cement (b) in group A and Group D.

Table 1: Pair–Wise Comparison Between The Groups For Comparing The Significant Difference In Mean Pull-Out Bond Strength

S. NO.	PAIR OF GROUPS	P- VALUES (BY INDEPENDENT "t" TEST)	SIGNIFICANCE
1	GROUP A & GROUP B	.0000* (P<.05)	SIGNIFICANT DIFFERENCE
2	GROUP A & GROUP C	.0000*(P<.05)	SIGNIFICANT DIFFERENCE
3	GROUP A & GROUP D	.0029*(P<.05)	SIGNIFICANT DIFFERENCE
4	GROUP B & GROUP C	.0000*(P<.05)	SIGNIFICANT DIFFERENCE
5	GROUP B & GROUP D	.0001*(P<.05)	SIGNIFICANT DIFFERENCE
6	GROUP C & GROUP D	.0002*(P<.05)	SIGNIFICANT DIFFERENCE

Table 2: Mode Of Failure As Evaluated Through Stereo microscopic Examination

(A)	Adhesive failure between Self-adhesive resin luting cement and Dentin **Group C > Group B > Group D > Group A**
(B)	Adhesive failure between Fibre post and Self-adhesive resin luting cement **Group A > Group D > (Group C and Group B)**
(C)	Cohesive failure in Fibre post **Group A> Group D (no Fibre post cohesive failure occurred in Group B and Group C)**
(D)	Cohesive failure in Self-adhesive resin luting cement **(Group A and Group D) > (Group B and Group C)**

DISCUSSION:

Debonding of resin cement from root dentin can result from limited light penetration in post space, presence of bubbles and gaps in the cement layer, high polymerization stresses (C-factor) generated at the adhesive cements and dentin interface, anatomic and morphological characteristics of the dentin and poor isolation thus leading to failure of fiber post assembly.[4]

Another reason for failure of bonding may be inappropriate removal of smear layer. Smear layer produced during post-space preparation consists of an agglomeration of dentin and traces of materials that have been used for obturation which hinders the penetration and adaptation of adhesive resin cement into dentin, thus affecting bond strength.[1]

Irrigation of post space with NaOCl and EDTA have been recommended to remove this smear layer and have been reported with varied outcomes. Nevertheless, NaOCl has been reportedly associated with reduced bond strength of self-adhesive resin luting cement[5] due to presence of nascent oxygen.

Use of antioxidant has been reported to reverse the deleterious effect of nascent oxygen hence this study was conducted to evaluate the effect of post space treatment on pull-out bond strength of RelyX U200 to dentin after treatment with NaOCl, EDTA and sodium ascorbate.
In the present study passive ultrasonic irrigation of post space with EDTA **(Group B)** or NaOCl and EDTA **(Group C)** resulted in decreased pull out bond strength of fiber post when compared to saline (**Group A**).

Irrigation with EDTA results in compromised chemical bonding between self-adhesive resin cements and dentin due to fewer Ca^{++} ions available in demineralized dentin and by selective removal of Ca++ ions, non-collagenous proteins and hydroxyapatite.[6] Studies suggest that adhesive properties of RelyX U200 partially depend upon a chemical interaction between its phosphoric acidic monomer and calcium hydroxyapatite present in post space dentin. Thus dentin demineralization leading to removal of calcium hydroxyapatite is deleterious for the bond strength of fiber post bonded with self-adhesive resin cements to root dentin.[6] Various authors[6,7,8] also reported decrease in bond strength of self-adhesive resin luting cement to fiber post after irrigation with EDTA.

NaOCl causes adverse effect on pyridinoline cross-links in type I collagen, which compromise the formation of hybrid layer as bonding of self-adhesive systems is directly related to the dentin quality and collagen integrity which works through two-way union: (i) hybridization of dentin by acidic monomers, and (ii) chemical interaction with hydroxyapatite.[9] The generation of free oxygen bubbles at the resin–dentin interface may directly interfere with resin infiltration into the tubules and inter-tubular dentin.[5] Oxygen produced by breakdown of NaOCl on contact with organic matter causes strong inhibition of the interfacial polymerization of methacrylate resins present in resin cements thus affecting the bond strength.[5] Various authors[6, 10, 11, 12, 13] reported decrease in bond strength of resin luting cement to dentin after irrigation with NaOCl.

The cleaning effect of PUI associated with saline can be attributed to cavitation and microstreaming effects of PUI on root canal walls. Some authors[6, 14, 8] reported EDTA/ NaOCl along with PUI resulted in decreased push-out bond strength of self-adhering cement to post dentin when compared to saline.

In the present study obturation was done with warm vertical compaction so the resultant smear layer formed during post space preparation might have been easily removed with PUI with saline without compromising the bond strength, leaving the root dentin and collagen undamaged.

However, a few studies in literature have found improved bond strength of self-adhering resin cements to NaOCl/ EDTA treated post space dentin. **Kul *et al*[15]** used cold lateral compaction and did not utilize PUI for post space irrigation, **Bitter *et al*[16]** utilized SmartCem2 which contains 10 MDP and 4-META.

B) Decrease in bond strength caused by treatment of post space with EDTA **(Group B)**, or EDTA/ NaOCl **(Group C)** was significantly reversed by treatment of post space with 10% sodium ascorbate **(Group D)**. Some authors[12, 17, 18] reported reversal in bond strength after treatment of post space or root dentin with 10% sodium ascorbate after irrigation with NaOCl.

Sodium ascorbate reverses the compromising effect of NaOCl on dentin bond strength by restoring the altered redox potential of the oxidized bonding substrate and allow free radical polymerization of the adhesive to proceed without premature termination, helps in the synthesis of hydroxyproline and hydroxylysine in collagen. Intermolecular collagen crosslinks are formed and collagen triple helix gets stabilized by hydroxylysine and Hydroxyproline respectively.[16] Integrity of collagen is neccessary for bonding of self-adhesive resin luting cements to dentin.

In the present study, failed samples in Group B and Group C when viewed under stereomicroscope, predominantly presented with adhesive bond failure between self-adhesive resin luting cement and fiber post (Fig. 1) thus pointing towards weak bond strength between two substrates.

On the other hand Group A predominantly presented with a mixed pattern of failure between fiber post and the self-adhesive resin luting cement (Fig. 2) and cohesive failures in fiber post as well. Relatively very few samples exhibited adhesive failure between cement and post space dentin as compared to Group B and Group C.

Failed samples of Group D also presented with a predominantly mixed pattern of failure between fiber post and the self-adhesive resin luting cement (Fig. 2) and cohesive failures in fiber post similar to samples of Group A. Relatively very few samples exhibited adhesive failure between cement and post space dentin as compared to Group B and Group C.

CONCLUSION

Irrigation of post space with PUI assisted saline resulted in higher pull-out bond strength values as compared to EDTA and NaOCl. Irrigation with EDTA or alternatively with EDTA and NaOCl assisted with PUI resulted in significantly reduced pull-out bond strength values. If post space is to be irrigated with EDTA/ NaOCl, use of 10% sodium ascorbate is critical for reversal of compromised pull-out bond strength values of fiber post bonded with self-adhesive resin luting cement.

However, the conclusions drawn from this study hold true in light of condition and limitations of present study. More studies are needed to be carried out to verify and validate the result of present study using different substrate, materials and techniques.

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