Journal of Advanced Medical and Dental Sciences Research

@Society of Scientific Research and Studies *NLM ID: 101716117*

Journal home page: www.jamdsr.com doi: 10.21276/jamdsr Index Copernicus value = 85.10

(e) ISSN Online: 2321-9599; (p) ISSN Print: 2348-6805

Original Research

A Comparative Evaluation of the effect of two different antioxidants on the bond strength of composite resin to pulp chamber dentin treated with sodium hypochlorite and Ethylenediaminetetraacetic Acid: An In Vitro Study

Ria Tandon[1], Jagat Bhushan[2], Amrita Rawla[3]

[1] Post Graduate Student, Department of Conservative Dentistry and Endodontics, Dr. Harvansh Singh Judge Institute Of Dental Sciences And Hospital, Panjab University , Chandigarh, India;
[2] Professor and Head, Department of Conservative Dentistry and Endodontics, Dr. Harvansh Singh Judge Institute Of Dental Sciences And Hospital, Panjab University , Chandigarh, India;
[3]Assistant Professor, Department of Conservative Dentistry and Endodontics, Dr. Harvansh Singh Judge Institute Of Dental Sciences And Hospital, Panjab University , Chandigarh, India

ABSTRACT:
OBJECTIVE- The aim of this in vitro study is to evaluate and compare the effect of two different antioxidants – 6.5% proanthocyanidin and 10% ascorbic acid on the bond strength of composite resin to pulp chamber dentin treated with sodium hypochlorite and ethylenediamine tetraacetic acid. **MATERIALS AND METHODS-** Thirty extracted human mandibular molar teeth were sectioned in a mesiodistal direction to expose the pulp chamber to obtain a total of sixty samples. The enrolled specimens were divided into 3 groups: Control Group(n=20), treated with 3% sodium hypochlorite (NaOCl) for 5 mins followed by treatment with 17% ethylenediamine tetraacetic acid (EDTA) for 5 mins ; Group A (n=20) ,after pretreatment with NaOCl and EDTA , the specimens were immersed in a solution of 6.5% Proanthocyanidin (PA) for 10 mins ; Group B(n=20) , following pretreatment with NaOCl and EDTA , specimens were further treated with 10% ascorbic acid solution for 10 mins. After drying the specimens, a self-etch adhesive, Prime and Bond Tm (Dentsply Caulk) was applied on pup chamber dentin followed by composite restoration (Ceram X Tm Sphere Tec Tm One Universal, Dentsply Sirona). Each specimen was then tested under a universal testing machine at dentin/resin interface to determine shear bond strength. **RESULTS-** The group in which 6.5% PA was used showed significantly higher bond strength than the 10% ascorbic acid group followed by the control group. ($p < 0.05$). **CONCLUSION-** Within the limits of this in vitro study it can be concluded that immediate application of proanthocyanidin and ascorbic acid can restore the compromised bond strength of composite resin to NaOCl/EDTA treated dentin. Proanthocyanidin can improve the bond strength significantly more than ascorbic acid.
Key words: Sodium Hypochlorite, Ehylenediamine Tetraacetic Acid, Proanthocyanidin

Received: 02/05/2020 **Modified:** 20/05/2020 **Accepted :** 15/06/2020

Corresponding Author: Dr. Ria Tandon, Post Graduate Student, Department of Conservative Dentistry and Endodontics, Dr. Harvansh Singh Judge Institute Of Dental Sciences And Hospital, Panjab University , Chandigarh, India

This article may be cited as: Tandon R, Bhushan J, Rawla A. A Comparative Evaluation of the effect of two different antioxidants on the bond strength of composite resin to pulp chamber dentin treated with sodium hypochlorite and Ethylenediaminetetraacetic Acid: An In Vitro Study. J Adv Med Dent Scie Res 2020;8(7):16-21.

INTRODUCTION

Successful root canal treatment relies on efficient cleaning, shaping and compact filling of the root canal under aseptic conditions. In addition to a good apical seal, a coronal seal is also mandatory in order to prevent micro leakage. [1] Apical periodontal health depends considerably more on the coronal restoration than on the technical quality of the endodontic treatment.[2] Therefore, the need for an immediate and proper restoration after endodontic treatment is of utmost importance.

Restoration using direct composite resin is a viable treatment option post endodontic therapy.[3] The resin-dentin interdiffusion zone, called the "hybrid layer," plays a key role in the micromechanical retention of the restoration.[4]

Chemicals used during root canal preparation may alter the composition and therefore the interaction of the dentin surface with restorative materials.[5] Sodium hypochlorite (NaOCl), an efficient organic solvent and antimicrobial agent is used widely as an irrigant for endodontic therapy. [6] Dentin is degenerated by NaOCl due to dissolution of dentinal collagen.[7] Also, NaOCl releases oxygen, and this oxygen could cause inhibition of the adhesive system penetration and polymerization, thus decreasing the bond strength values.[8,9]

Ethylenediamine tetraacetic acid (EDTA), a chelating agent on the other hand can expedite the destructive hypochlorite effect and facilitate hydroxyl ion diffusion through dentinal tubules. [10]

The strengthening of collagen fibrils by crosslinking agents may be of clinical importance in improving dentin bond strength.[11] Some studies have shown that application of an antioxidant after NaOCl treatment can restore compromised bond strengths. [8,12,13,14]

In the present study , we compared the potential effects of proanthocyanidin (PA) and ascorbic acid on the recovery of shear bond strength to pulp chamber dentin treated with NaOCl and EDTA. The null hypothesis was that neither 6.5% proanthocyanidin nor 10% ascorbic acid solution would be effective in reversing the bond strength to dentin compromised by NaOCl and EDTA.

MATERIALS AND METHODS

Preparation of Solutions

Two solutions were prepared for this study:

1) 6.5 g of grape seed extract (NuSci, ebay) in the form of powder dissolved in 100 mL of distilled water to make 6.5% proanthocyanidin solution and,

2) 10 g of ascorbic acid powder (VitaeGen Life Sciences, Amazon) were dissolved in 100 mL of distilled water to make 10% ascorbic acid solution.

Specimen Preparation

Thirty freshly extracted human mandibular molar teeth were collected for the study, cleaned of debris and stored in distilled water until use. Any teeth with carious lesion or surface cracks were excluded from the study. They were then sectioned in a mesiodistal direction using a low speed circular diamond disc to expose the pulp chamber and a total of sixty sectioned samples were obtained. The contents of pulp chamber were removed with a spoon excavator. Further the buccal/ lingual wall of each half of the crown occlusal to the cementoenamel junction was removed with a diamond disc until the remaining dentin thickness (RDT) was approximately 1.5mm as measured with a metal caliper (Safeseed® Electronic Digital Vernier Caliper Ruler). Specimens were kept in distilled water prior and after examination. The enrolled specimens were divided into 3 groups of 20 specimens each.

CONTROL GROUP (n=20) - Initially, specimens were immersed in a solution of 3% NaOCl solution (Hyposol, Prevest Denpro Limited) for 5 mins (Fig 1A), then rinsed with saline. Next specimens were immersed in a solution of 17% EDTA (Prevest Dentro Limited) for 5 mins (Fig 1B), followed by saline.

GROUP A (n=20) - After pretreatment with NaOCl and EDTA (Fig 2A & 2B), the specimens were immersed in a solution of 6.5% PA solution for 10 mins (Fig 2C)

GROUP B (n=20) - After pretreatment with NaOCl and EDTA (Fig 3A & 3B), the specimens were immersed in 10% ascorbic acid solution for 10 mins (Fig 3C)

Bonding Protocol

Before bonding procedure, specimens were blot dried using cotton pellets. A self-etch adhesive system, Prime and Bond Tm (Dentsply Caulk) was coated on the surface of pulp chamber dentin using a micro applicator tip (Dentsply) according to manufacturer's instructions and cured for 20 secs . After the application of the bonding agent, each specimen received a nano - ceramic composite resin (Ceram X Tm Sphere Tec Tm One Universal , Dentsply Sirona), placed incrementally. Each bonded specimen was then cured using light-curing unit (Elipar Highlight, 3M ESPE) for 20 secs. After the bonding procedure, the samples were stored in distilled water until testing.

Shear Bond Strength Testing

Shear bond strength of the composite resin to the tooth surface was determined using a universal testing machine (BISS, Bangalore Integrated System Solutions, India) at a crosshead speed of 1 mm/min. The mounted specimen with the test load has been shown in Fig 4. Load was applied until restoration failure. The results were tabulated and statistically analyzed. Statistical analysis was performed with the help of SPSS software v20. Data was analyzed using one way analysis of variance (one way ANOVA). Level of statistical significance was defined at $p<0.05$

RESULTS

The shear bond strength means and standard deviations are shown in Table 1. Statistical Analysis revealed that control group with NaOCl + EDTA showed significantly lower bond strength to pulp chamber dentin ($P < 0.05$) as compared to Group A and Group B. The specimens that were immersed in a solution of 6.5%PA (Group A) yielded significantly higher shear bond strength values than the ones immersed in 10% ascorbic acid solution (Group B) ($p< 0.05$)

Table 1 : Shear Bond Strengths(MPa) And Standard Deviations

GROUPS	SAMPLE SIZE	MEAN (MPa)	STANDARD DEVIATION
CONTROL(NaOCl+EDTA)	20	22.05	4.35
GROUP A (NaOCl+EDTA+6.5% PA)	20	29.84	5.11
GROUP B (NaOCl+ EDTA+ 10% ascorbic acid)	20	26.85	4.74
Significant groups- Control vs Group A vs Group B (p<0.05)			

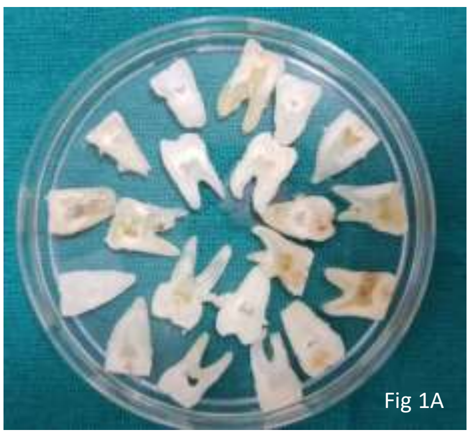

Fig 1A- TOOTH SAMPLES IMMERSED IN SODIUM HYPOCHLORITE

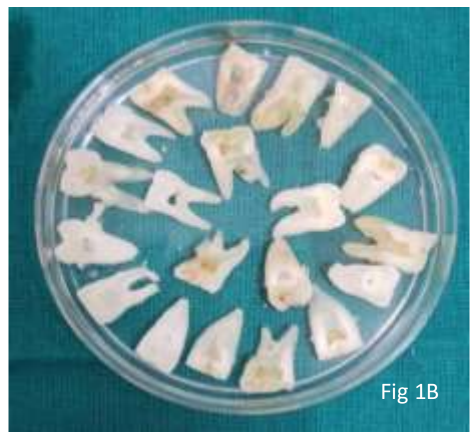

Fig 1 B- TOOTH SAMPLES IMMERSED IN ETHYLENEDIAMINE TETRRAACETIC ACID

Fig 2A: TOOTH SAMPLES IMMERSED IN SODIUM HYPOCHLORITE
Fig 2B: TOOTH SAMPLES IMMERSED IN ETHYLENEDIAMINE TETRRAACETIC ACID
Fig 2C: TOOTH SAMPLES IMMERSED IN PROANTHOCYANIDIN SOLUTION

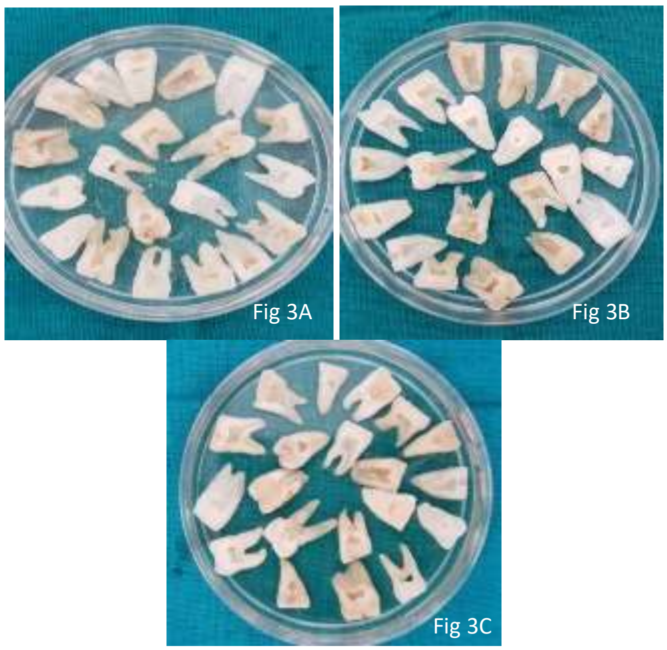

Fig 3A- TOOTH SAMPLES IMMERSED IN SODIUM HYPOCHLORITE
Fig 3 B- TOOTH SAMPLES IMMERSED IN ETHYLENEDIAMINE TETRRAACETIC ACID
Fig 3C- TOOTH SAMPLES IMMERSED IN ASCORBIC ACID SOLUTION

FIG 4 : MOUNTED TOOTH SAMPLE WITH TEST LOAD IN THE UNIVERSAL TESTING MACHINE

DIRECTION OF TEST LOAD

DISCUSSION

Resin- dentin bonding is a special form of tissue engineering that relies on a demineralized dentin collagen matrix used as a scaffold to create a hybrid layer which couples the adhesive/ resin composite to the underlying dentin.[15] Bonding efficiency depends largely on structural integrity and mechanical properties of acid-demineralized collagen fibers.

To our knowledge, this study is one of the few comparing the potential of proanthocyanidin and ascorbic acid to recover the dentin bond strength lost with the use of commonly used endodontic irrigants.

Endodontic irrigants alter the structure of dentin, mainly collagen that interferes with dentin/resin bonding .[16] NaOCl treatment has a negative impact on the mechanical properties of dentin i.e. its flexural strength and elastic modulus. [17] Removal of collagen fibrils from the dentin surface by sodium hypochlorite may impede the formation of a consistent hybrid layer.[18] Moreover the oxidizing capacity of NaOCl leads to generation of oxygen free radicals that might compete with the propagating vinyl-free radicals generated during light activation of the adhesive system, resulting in premature chain termination and incomplete polymerization.[9]

EDTA has a strong demineralizing effect, causing widening of the dentinal tubules, denaturation of collagen fibers and softening of dentin. [19]

On the other hand antioxidants (eg. PA and Ascorbic acid) with their free radical scavenging action can reverse the NaOCl and EDTA compromised bond strength. Grape seed extract (GSE) is a naturally occurring antioxidant. It contains oligomeric proanthocyanidin (PA) complexes (OPCs). PA or condensed tannins is composed of flavon-3-ol subunits, catechin, epicatechin and epicatechin-3-O-gallate, linked mainly through C4 - C8 (20). They possess antibacterial, antiviral, anticarcinogenic, anti-inflammatory, and anti-allergic activities. They are natural extracts, thus lack toxicity. OPCs contain numerous electron donor sites (hydroxyl sites) that allow it to bind to free radicals by giving away its hydrogen atoms. They also increase the number of inter- and intramolecular collagen cross links.[21]

In the present study we observed increased shear bond strength with 6.5% PA [group A (29.84±5.11)] as compared with 3% NaOCl [Control (22.05±4.35)]. This is in accordance with the study conducted by Benin Dikmen et al. The reducing activity of PA reverses the oxidizing effect of NaOCl , restoring the redox potential of the oxidized dentin. [22]

Ascorbic acid is the most essential component in the synthesis of hydroxyproline and hydroxylysine in collagen. [23] In the present study, there is a statistically significant increase in the bond strength with 10% ascorbic acid [Group B (26.85 ±4.74)] , as compared with 3% NaOCl [Control(22.05±5.35)] which indicates that ascorbic acid reverses the lost bond strength. Its antioxidant properties convert the oxidized substrate to a reduced substrate which restores the redox potential of the dentin .This allows free radical polymerization of the adhesive to proceed without premature termination. [24] It is nontoxic, and its intraoral use is unlikely to cause any harmful biological effects.

In this study, 6.5% PA [group A (29.84±5.11)] showed the maximum bond strength among all the groups. There was a significant difference ($p<0.05$) in the bond strength between 6.5% PA [group A (29.84±5.11)] and 10% ascorbic acid [Group B (26.85 ±4.74)]. PA contains gallic acid that may act as a critical factor in maximizing its free radical scavenging ability. Gallic acid is only found only in grape seed extract. [26]

Hence, the null hypothesis was rejected as both 6.5% proanthocyanidin and 10% ascorbic acid solution were seen to be effective in reversing the bond strength to dentin compromised by NaOCl and EDTA.

CONCLUSION

Within the limits of this in vitro study it can be concluded that application of proanthocyanidin and ascorbic acid can revert the bond strength compromised by the use of sodium hypochlorite and ethylenediamine tetraaacetic acid. Proanthocyanidin was seen to improve the bond strength significantly more than ascorbic acid.

This new protocol could be an adjunct approach to achieve more durable dentin bonding .Yet further research is required to evaluate optimum level, biocompatibility and safety factors of these antioxidants to be used in routine endodontic practice. In vivo studies remain necessary to validate these laboratory results.

REFERENCES

1. Gillen BM, Looney SW, Gu LS, Loushine BA, Weller RN, Loushine RJ, Pashley DH, Tay FR. Impact of the quality of coronal restoration versus the quality of root canal fillings on success of root canal treatment: a systematic review and meta-analysis. Journal of endodontics. 2011 Jul 1;37(7):895-902.
2. Slutzky-Goldberg I, Slutzky H, Gorfil C, Smidt A. Restoration of endodontically treated teeth review and treatment recommendations. International journal of dentistry. 2009 Jan 1;2009.
3. Belli S, Eraslan O, Eskitascioglu G. Direct Restoration of Endodontically Treated Teeth: a Brief Summary of Materials and Techniques. Current Oral Health Reports. 2015 Dec 1;2(4):182-9
4. Nakabayashi N, Nakamura M, Yasuda N. Hybrid layer as a dentin-bonding mechanism. Journal of Esthetic and Restorative Dentistry. 1991 Jul;3(4):133-8.
5. Abuhaimed TS, Abou Neel EA. Sodium hypochlorite irrigation and its effect on bond strength to dentin. BioMed research international. 2017;2017.

6. Mohammadi Z. Sodium hypochlorite in endodontics: an update review. International dental journal. 2008 Dec;58(6):329-41.
7. Ishizuka T, Kataoka H, Yoshioka T, Suda H, Iwasaki N, Takahashi H, Nishimura F. Effect of NaClO treatment on bonding to root canal dentin using a new evaluation method. Dental materials journal. 2001;20(1):24-33.
8. Lai SC, Mak YF, Cheung GS, Osorio R, Toledano M, Carvalho RM, Tay FR, Pashley DH. Reversal of compromised bonding to oxidized etched dentin. Journal of Dental Research. 2001 Oct;80(10):1919-24.
9. Santos JN, de Oliveira Carrilho MR, De Goes MF, Zaia AA, de Almeida Gomes BP, de Souza-Filho FJ, Ferraz CC. Effect of chemical irrigants on the bond strength of a self-etching adhesive to pulp chamber dentin. Journal of endodontics. 2006 Nov 1; 32(11):1088-90.
10. Saif S, Carey CM, Tordik PA, McClanahan SB. Effect of irrigants and cementum injury on diffusion of hydroxyl ions through the dentinal tubules. Journal of endodontics. 2008 Jan 1;34(1):50-2.
11. Bedran - Russo AK, Pereira PN, Duarte WR, Drummond JL, Yamauchi M. Application of crosslinkers to dentin collagen enhances the ultimate tensile strength. Journal of Biomedical Materials Research Part B: Applied Biomaterials: An Official Journal of The Society for Biomaterials, The Japanese Society for Biomaterials, and The Australian Society for Biomaterials and the Korean Society for Biomaterials. 2007 Jan;80(1):268-72.
12. Manimaran VS, Srinivasulu S, Ebenezar AR, Mahalaxmi S, Srinivasan N. Application of a proanthocyanidin agent to improve the bond strength of root dentin treated with sodium hypochlorite. Journal of conservative dentistry: JCD. 2011 Jul;14(3):306.
13. Liu RR, Fang M, Zhang L, Tang CF, Dou Q, Chen JH. Anti-proteolytic capacity and bonding durability of proanthocyanidin-biomodified demineralized dentin matrix. International journal of oral science. 2014 Sep;6(3):168-74.
14. Morris MD, Lee KW, Agee KA, Bouillaguet S, Pashley DH. Effects of sodium hypochlorite and RC-prep on bond strengths of resin cement to endodontic surfaces. Journal of Endodontics. 2001 Dec 1;27(12):753-7.
15. Breschi L, Mazzoni A, Ruggeri A, Cadenaro M, Di Lenarda R, Dorigo ED. Dental adhesion review: aging and stability of the bonded interface. dental materials. 2008 Jan 1;24(1):90-101.
16. Barutcigil Ç, Harorlı OT, Özcan E, Arslan H, Yıldız M. Effects of ethylenediaminetetraacetic acid and sodium hypochlorite on the bond strength of bonding agents to pulp chamber lateral walls. Journal of Dental Sciences. 2014 Sep 1;9(3):229-34.
17. Sim TP, Knowles JC, Ng YL, Shelton J, Gulabivala K. Effect of sodium hypochlorite on mechanical properties of dentine and tooth surface strain. International Endodontic Journal. 2001 Mar;34(2):120-32.
18. Maior JR, Figueira MA, Netto AB, Souza FB, Silva CH, Tredwin CJ. The importance of dentin collagen fibrils on the marginal sealing of adhesive restorations. Operative dentistry. 2007 Jun;32(3):261-5.
19. Garberoglio R, Becce C. Smear layer removal by root canal irrigants: a comparative scanning electron microscopic study. Oral surgery, oral medicine, oral pathology. 1994 Sep 1;78(3):359-67.
20. Cavaliere C, Foglia P, Gubbiotti R, Sacchetti P, Samperi R, Laganà A. Rapid-resolution liquid chromatography/mass spectrometry for determination and quantitation of polyphenols in grape berries. Rapid Communications in Mass Spectrometry: An International Journal Devoted to the Rapid Dissemination of Up-to-the-Minute Research in Mass Spectrometry. 2008 Oct 30;22(20):3089-99.
21. Boteon AP, Kato MT, Buzalaf MA, Prakki A, Wang L, Rios D, Honório HM. Effect of proanthocyanidin-enriched extracts on the inhibition of wear and degradation of dentin demineralized organic matrix. Archives of oral biology. 2017 Dec 1;84:118-24.
22. Dikmen B, Gurbuz O, Ozsoy A, Eren MM, Cilingir A, Yucel T. Effect of different antioxidants on the microtensile bond strength of an adhesive system to sodium hypochlorite-treated dentin. J Adhes Dent. 2015 Dec;17(6):499-504.
23. Murad S, Grove D, Lindberg KA, Reynolds G, Sivarajah A, Pinnell SR. Regulation of collagen synthesis by ascorbic acid. Proceedings of the National Academy of Sciences. 1981 May 1;78(5):2879-82.
24. Vongphan N, Senawongse P, Somsiri W, Harnirattisai C. Effects of sodium ascorbate on microtensile bond strength of total-etching adhesive system to NaOCl treated dentine. Journal of dentistry. 2005 Sep 1;33(8):689-95.
25. Weston CH, Ito S, Wadgaonkar B, Pashley DH. Effects of time and concentration of sodium ascorbate on reversal of NaOCl-induced reduction in bond strengths. Journal of Endodontics. 2007 Jul 1;33(7):879-81.
26. Fine AM. Oligomeric proanthocyanidin complexes: history, structure, and phytopharmaceutical applications. Alternative medicine review: a journal of clinical therapeutic. 2000 Apr;5(2):144-51.