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To evaluate effect of three different reducing agents in recovery of bond strength to sodium hypochlorite treated dentin with composite resin: An in vitro study

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***Abstract*---**Background: Endodontically treated teeth lose a large proportion of their structure due to trauma and caries and during endodontic treatment. As a result, they have low physical properties, fracture resistance, and esthetic appearance. The study aims to evaluate the anti-oxidant efficacy of sodium thiosulphate, citric acid and gallic acid on the recovery of shear bond strength to pulp chamber dentin treated with NaOCI & EDTA. Methodology: 50 single rooted second premolars were divided into 5 groups (n=10); Positive control received no treatment; negative control received only irrigation treatment, while the other two experimental groups were treated with

their respective anti-oxidant following the irrigation. All the samples were then cured with composite and subjected to SBS test under a universal testing machine. Statistical analysis: ANOVA & Post hoc tukey were used with P <0.5. Results: Anti-oxidant groups showed a greater mean SBS value than the negative control, comparable to positive control. The sodium thiosulfate group showed the highest value with a significant difference from the negative control group. Conclusion: Both the anti-oxidants used were able to restore the Shear bond strength of pulp chamber dentin altered due to endodontic irrigants. Hence, possesses great potential in its clinical implication.

***Keywords*---**Anti-oxidant, shear bond strength, sodium hypochlorite, sodium thiosulfate, citric acid, gallic acid.

Introduction

Endodontically treated teeth lose a large proportion of their structure due to trauma, caries & endodontic treatment. Due to this, they have low physical properties, fracture resistance and esthetic appearance.
Hence, endodontically restored teeth is a very important step to achieving clinical success and restoring function and esthetic.[1]

Sodium hypochlorite (NaOCl) is widely used as a chemical irrigant for endodontic therapy due to its antibacterial and organic tissue dissolution properties. The remnants and by-products of NaOCl exhibit a negative effect on the polymerization of dental adhesive systems[2,3]. On the other hand, these compromised bond strengths to NaOCl-treated dentin could be restored by more than 60 seconds of application of 10% citric acid (antioxidant) solution before the adhesive procedure, because it can interact with the by-products of NaOCl , resulting in neutralization and reversal of the oxidizing effect of the NaOCl-treated dentin surface. Sodium thiosulfate has ability to neutralize the oxidizing agents through redox reaction of the treated substrate, facilitating complete polymerization of resin bonding material.

10% Gallic acid is a very active phenolic acid with highest radical scavenging activity in the group of phenolic acid. The redox potential of gallic acid helps to remove the residual oxygen following the use of sodium hypochlorite and thus improves the bond strength of dentin with composite resin. 10% citric acid has antimicrobial properties due to its acidulation but it is also used as an antioxidant indirectly by chelating metal ion that catalyses oxidation.
This in vitro study aimed to evaluate the antioxidant efficacy of sodium thiosulfate, citric acid and gallic acid on the recovery of the bond strength to pulp chamber dentin treated with NaOCl and EDTA.

Materials and Methods

Fifty human single canal mandibular second premolars freshly extracted for orthodontic reasons were selected for this study. These teeth were cleaned and

stored in physiological saline at 40^{0}C before use. Strict anonymization was observed while collecting the teeth. Teeth with root crack, caries, restoration and previous endodontic treatments were excluded. Endodontic access cavity preparation was done in 50 teeth using a #2 round diamond bur. The teeth selected had a minimal apical diameter corresponding to a size 20 K-file. The working length was determined using a size 15 K file and set as initial apical file. The canals were prepared till F1 protaper rotary file. The canals were debrided using 5.25%sodium hypochlorite and normal saline irrigant. The root canal of each tooth was dried with paper points and obturated using cold lateral compaction with 6% gutta percha and AH plus root canal sealer.
For the study, these 50 teeth were randomly divided into 5 groups of 10 sample each.
Group 1: Negative Control: The teeth were treated with saline as irrigant without any treatment with NaOCl/EDTA
Group 2- The teeth were treated with 5.25% of NaOCl/EDTA and treatment with 10% Citric acid as a reducing agent for 30 mins.
Group 3: The teeth were treated with 5.25% of NaOCl/EDTA and treatment with 10% Sodium thiosulfate as a reducing agent for 30 mins.
Group 4: The teeth were treated with 5.25% of NaOCl/EDTA and treatment with 10% Gallic acid as a reducing agent for 30 mins.
Group 5: Positive Control: The teeth were treated with 5.25% of NaOCl /EDTA
All the study samples were restored using composite resin (Filtek Z350) by using an incremental technique and cured with a LED Curing light (Coltulux LED curing /Whaldent).

The restorations were contoured, finished, and polished with a series of abrasive disks (super-snap; Shofu Inc Kyoto, Japan). The teeth were restored in distilled water for 24 hours at 37^{0}C before being subjected to fracture testing. The roots of the teeth were mounted in self-cure acrylic resin of 3cm*2.5cm up to the level of 1mm apical to CEJ.

Fracture testing

The prepared specimens were placed on a holder slot that was fixed to the lower arm of the universal testing machine. A metal indenter with a 6-mm diameter was fixed to the upper arm of a universal testing machine that will be set to deliver increasing loads until fracture occurred. The load was applied to the occlusal inclines of the buccal and lingual cusps vertically along the long axis of the tooth at a crosshead speed of 1 mm/min.

Results

The fracture resistance of all groups was evaluated by using universal testing machine. The load required to fracture sample was recorded. Data obtained was entered and sorted in Microsoft Excel (v.2013). Statistical analysis was performed using Statistical package for social sciences (SPSS) software (v.21.0)

Intergroup comparison of bond strength between different groups was performed using One-way Analysis of Variance (ANOVA) and post hoc Tukey's test to assess

significant differences. All statistical tests were performed at 95% confidence intervals; keeping p value of less than 0.05 as statistically significant
Table 1. shows bond strength and standard deviation for groups 1, group 2, group 3, group 4, group 5. By using Independent t- test, it was observed that there was statistically significant difference in the values of bond strength of dentin for the groups. Group 3 (Sodium Thiosulfate, 34.51 MPa) showed higher bond strength than Group 2 (Citric acid,30.11MPa) group 4(gallic acid 23.23). Dentin bond strength was higher in group 3 compared to all the groups, followed by group 2, 4,1 and 5 and respectively

Discussion

This in vitro study intended to evaluate the antioxidant efficacy of sodium thiosulfate, citric acid and gallic acid on the recovery of the bond strength to pulp chamber dentin treated with NaOCl and EDTA. Results of this in vitro study showed dentin bond strength in all the five groups. As far as the antioxidant was concerned, sodium thiosulfate had higher bond strength (Group 3 , 34.51 MPa) than Citric acid ,30.11MPa) group 4 (gallic acid 23.23).

The dentin surface of endodontically treated teeth is generally contacted by mechanical instrumentation, irrigation, medication, and temporary restoration. Sodium hypochlorite and hydrogen perioxide are the most common endodontic irrigants used for deproteinization of mechanically prepared root dentin. However, sodium hypochlorite or hydrogen peroxide treatment of dentin results in potent biological oxidation and reduces the bond strength between resin composite and dentin. These residual irrigant solutions and their products are likely to diffuse into the dentin and decrease the bond strength.[4]

Very few studies are conducted on sodium thiosulfate but they evaluated that sodium thiosulfate had better bond strength. Sodium thiosulphate neutralizes the oxidizing agent, through the redox reaction and leads to optimal polymerization of the resin composite. But 3.5ml and more quantity of Sodium thiosulphate are required to neutralize 5% sodium hypochlorite. This neutralization reaction also results in formation of yellow precipitates of sodium sulphate and sodium chlorides and reducing the effect of sodium thiosulphate.[5] In this research, 10% ascorbate solution was placed on the teeth surface for 30 minutes after applying 5.25% sodium hypochlorite for 1 minute on the teeth surface, which increased the bond strength of composite to dentin and increased the mean bond strength from 12.71 MPa to 29.43 MPa although this amount did not reach the level of normal saline control group.

In this study, the bond strength increased significantly (30MPa) after rinsing samples treated with sodium hypochlorite with 10% citric acid, which was even significantly more than the bond strength of the control group. When the samples were rinsed with water for 10 minutes after treatment with sodium ascorbate, the strength of the band did not differ significantly with the group treated with sodium hypochlorite.

The reason for the reduction in bond strength may be attributed to the technical sensitivity of total etching to moisture content of the dentin. The products

produced by the reaction of citric acid and sodium hypochlorite cause a higher bond strength of the group treated with citric acid, but when water was used after sodium ascorbate, the progress and upgrade of the band has not been accepted. So it was shown that sodium thiosulfate greater resistance to fracture as compared to citric acid and gallic acid but in negative control group values shows better results from the other three groups. Çelik et al stated that the effect of antioxidants also depends on the type of adhesive systems and their specific compositions. Kaya and Türkün22 demonstrated that a sodium ascorbate application might reverse the decreased bond-strength values of a two-step self-etch adhesive system (CLEARFIL SE Bond) after several bleaching procedures. The results of this study were consistent with Moezizadeh et al. Turkun et al. and Gokce et al. In all of these studies, sodium ascorbate was used after treated with sodium hypochloride, and there was a marked increase in the bond strength of the composite to the enamel.

This being an in vitro study, effects of other factors in the oral environment like oral fluids, tissue fluids or periapical fluids on the sealing ability of sealers could not be evaluated. These in vitro results cannot be extrapolated to in vivo situations, but they do permit reasonable comparison. Hence, further investigations are required to validate the choice of antioxidants during the root canal treatment.

Conclusion

Within the limitations of this in vitro study it can be concluded that, we conclude that

1. The bond strength of composite resin to sodium hypochlorite treated dentin is reduced because of potent biological oxidation of dentin
2. 10% Sodium thiosulfate when used as a reducing agent over sodium hypochlorite treated dentin showed maximum bond strength of composite resin to dentin followed by 10% Citric acid and 10% Gallic acid when used as reducing agent
3. The bond strength offered by use of Sodium thiosulfate as reducing agent was comparable to that of negative control group where saline was only irrigant used.

Thus, we recommend use of reducing agent (sodium thiosulfate, citric acid, gallic acid) to improve bond strength of composite resins to dentin when sodium hypochlorite is used as irrigant for root canal treatment
Hence, a great potential to be clinically used and thus promises more better results

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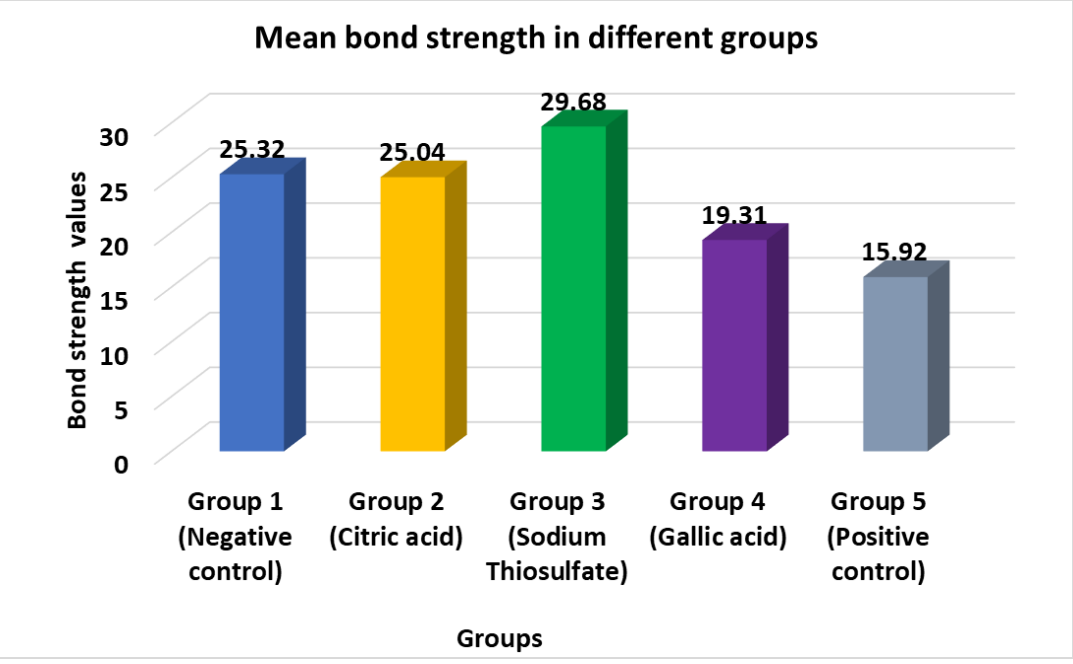
Table 1 – Descriptive statistics (Mean ± SD) of bond strength in different groups

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Group 1 (Negative control)	10	22.52	28.92	25.32	2.17
Group 2 (Citric acid)	10	22.11	30.11	25.04	2.45
Group 3 (Sodium Thiosulfate)	10	26.26	34.51	29.68	2.28
Group 4 (Gallic acid)	10	16.23	23.23	19.31	2.18
Group 5 (Positive control)	10	11.22	19.32	15.92	2.29



Graph 1- Comparison of mean bond strength of different groups