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A Comparative Evaluation Of 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
Introduction: 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. On the other hand, these compromised bond strength to NaOCL-treated dentin could be restored by antioxidant solution before the adhesive procedure, as it interacts with the by-products of NaOCL. This study aimed to evaluate the anti-oxidant efficacy of sodium thiosulphate, peracetic acid and gallic acid on the recovery of shear bond strength to pulp chamber dentin treated with NaOCL and EDTA. Materials and methods: 50 single rooted second premolars were divided into 5 groups(n=10); based on reducing agents used along with irrigating solution. Group 1: Positive control (no treatment), Group 2: Negative control (only irrigation using NaOCL and EDTA), Group 3: Sodium thiosulphate, Group 4: peracetic acid, Group 5: Gallic acid as reducing agent following irrigation. All the samples were then light cured with composite (Ivoclar Tetric N-Ceram) and subjected to shear bond strength test under a universal testing machine. Statistical analysis: Data were analysed using One-way Analysis of Variance (ANOVA) and post hoc Tukey's test to assess significant differences. Results: The sodium thiosulfate group showed the highest recovery of bond strength followed by peracetic acid and gallic acid. Conclusion: Use of Anti-oxidant improves the shear bond strength of the dentin altered due to endodontic irrigant. Hence, possesses great potential in its clinical implication.
Keywords- *Anti-oxidant, shear bond strength, sodium hypochlorite, sodium thiosulphate, gallic acid, peracetic acid.*

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I. 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[1]. The dentin surface of endodontically treated teeth is generally contacted by mechanical instrumentation, irrigation, medication and temporary restoration. Sodium hypochlorite and hydrogen peroxide are the most common endodontic irrigants used for deproteinization of mechanically prepared root dentin.

Sodium hypochlorite (NaOCl) is widely used as a chemical irrigant for endodontic therapy due to its antibacterial and organic tissue dissolution properties[2]. Many researchers have demonstrated that NaOCl reduces the bond strength between resin composites and dentin[3-6]. This is thought to be due to remnants and by-products of NaOCl exhibiting a negative effect on the polymerization of dental adhesive systems[6]. The compromised bond strength to NaOCL-treated dentin can be restored by Antioxidants (The Antioxidant solution has the ability to increase the bond strength before adhesive procedure) as it can interact with the by-products of NaOCL.

Sodium thiosulfate has ability to neutralize the oxidizing agents through redox reaction of the treated substrate, facilitating complete polymerization of resin bonding material[7]. 1% Peracetic acid is an organic acid which obtained by reacting acetic acid and hydrogen peroxide. Peracetic acid is soluble in water and is completely biodegradable. On breaking down it is converted into harmless products[8]. 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[9].

Therefore the aim of the study was to evaluate the effect of reducing agents like 10% sodium thiosulphate, 1% peracetic acid, 10% gallic acid with a short application time(1 min) on the shear bond strength of a single step self-etching adhesive system (G-Premio bond, GC, Tokyo, Japan) to NaOCL-treated dentin[10] and restored using composite resin (Ivoclar Tetric N-Ceram).The Null Hypothesis is that there is no difference in recovery of bond strength to 10% sodium thiosulphate, 1% peracetic acid, 10% gallic acid to sodium hypochlorite treated dentin with composite resin.

II. Materials And Methods

Fifty human single canal mandibular second premolars freshly extracted for orthodontic purpose were selected for this study. These teeth were cleaned and stored in physiological saline at 40^0C before use. Teeth with previous white spot lesions, caries and/or signs of cavitation, cracks and/or Fracture, signs of wear including attrition, abrasion, erosion and abfraction, hypoplasia, previous endodontic treatment were excluded.

Endodontic access cavity preparation was done in 50 teeth using a #2 round diamond bur (Mani) and safe end bur (EX 24 Mani). 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, 17% ETDA 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 RC Seal as root canal sealer.

For the study, these 50 teeth were randomly divided into 5 groups of 10 sample each.

Group 1: The teeth were treated with saline as irrigant

Group 2: The teeth were treated with 5.25% of NaOCl /EDTA

Group 3: The teeth were treated with 5.25% of NaOCl/EDTA and treatment with 10% Sodium Thiosulphate as a reducing agent for 1 min.

Group 4: The teeth were treated with 5.25% of NaOCl/EDTA and treatment with 1% Peracetic acid as a reducing agent for 1 min.

Group 5: The teeth were treated with 5.25% of NaOCl/EDTA and treatment with 10% Gallic acid as a reducing agent for 1 min.

All the study samples were air dried and then single step self-etching adhesive system (G-Premio bond GC, Tokyo, Japan) were applied to NaOCL-treated dentin and restored using composite resin (Ivoclar Tetric N-Ceram) by using an incremental technique and cured with a LED Curing light (I Led Plus woodpecker, India).

The restorations were contoured, finished and polished with a series of abrasive discs (super-snap; Shofu Inc Kyoto, Japan). The teeth were restored in distilled water for 24 hours at 37°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. The prepared specimens were placed on a holder slot that was fixed to the lower arm of the universal testing machine.

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 were 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. The shear bond strength 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:

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.

III. Results

Table 1. shows bond strength and standard deviation and Table 2. shows p value for group 1, group 2, group 3, group 4, group 5. When bond strength of Group 1 was compared with Group 2 no statistically significant difference was observed. ($p>0.05$) Group 1 showed statistically high significant difference with other groups respectively ($p<0.001$).

There was statistically high significant difference in the bond strength when sodium thiosulphate was compared with all other groups($p<0.001$).

Group 3 (Sodium Thiosulfate) showed higher bond strength than Group 2 (Peracetic acid) and group 4(gallic acid). Dentin bond strength was higher in group 3 compared to all the groups, followed by group 4,5,1 and 2 respectively.

Table 1: Comparison of bond strength and standard deviation

	N	Mean	Std. Deviation	Minimum	Maximum
Group 1	10	7.9400	2.28875	3.22	11.32
Group 2	10	5.9850	2.01536	2.04	9.32
Group 3	10	18.4890	2.20090	15.02	21.84
Group 4	10	13.6730	1.28808	11.40	16.05
Group 5	10	11.5110	1.49771	9.05	14.11

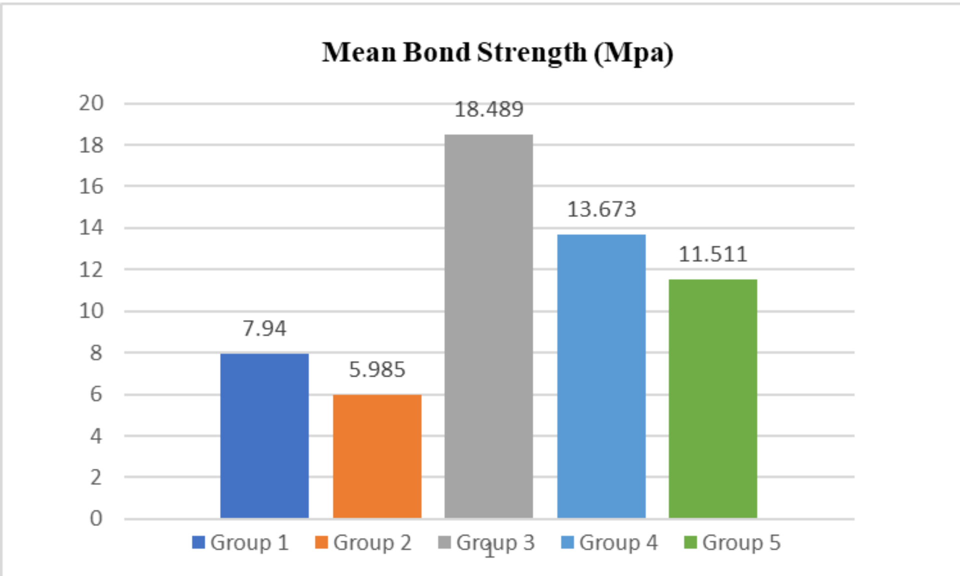

Table 2: Comparison of p value

	Only Saline	Sodium Thiosulphate	1% Peracetic Acid	Gallic acid	NaOCl and EDTA
Group 1	-	<0.001	<0.001	0.001	0.163
Group 2	0.169	<0.001	<0.001	<0.001	-
Group 3	<0.001	-	<0.001	<0.001	<0.001
Group 4	<0.001	<0.001	-	0.099	<0.001
Group 5	0.001	<0.001	0.099	-	<0.001

IV. Discussion

During root canal treatment dentin surface of teeth is generally contacted by mechanical instrumentation, irrigation, medication, and temporary restoration. Most commonly used endodontic irrigant is Sodium hypochlorite.[11] They are used for deproteinization of mechanically prepared root dentin. However, sodium hypochlorite treatment of dentin results in potent biological oxidation and reduces the bond strength between resin composite and dentin.[12] This compromised bonding is thought to arise because the reactive residual free-radicals generated by the oxidizing effect of NaOCl compete with the propagating vinyl free-radicals generated during light-activation of the adhesive, leading to incomplete polymerization by premature chain termination.[13,14,15,16,17] The three main mechanisms of antioxidant agents is to control oxidation, which include free radical chain-breaking, metal-chelating and free radical quenching mechanisms.[18]

Sodium Thiosulphate has been used in many microbiology studies to neutralize sodium hypochlorite, including clinical studies showing biocompatibility.[19,20] An initial cytotoxic assessment of sodium thiosulphate in contact with fibroblast cells has been performed by means of the methyl-thiazolyl-diphenyl tetrazolium bromide assay, the results of which show that concentrations of 0.5% and 5% are compatible with cell viability, suggesting routine clinical use. 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.[7] Therefore, there is need to find other antioxidant which can replace sodium thiosulphate. Hence 1% peracetic acid which is soluble in water and biodegradable and 10% Gallic acid were used in this study.

1% Peracetic acid is an organic acid generated by reacting acetic acid and hydrogen peroxide. It is soluble in water and is completely biodegradable, breaking down to harmless products.[8] 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.[9]

In this study we calculated bond strength in five different groups and concluded that sodium thiosulfate had higher bond strength (18.48 MPa) than Peracetic acid (13.67 MPa) and gallic acid (11.51 MPa). Thus, the null hypothesis is rejected and there is difference in recovery of bond strength to 10% sodium thiosulphate, 1% peracetic acid, 10% gallic acid to sodium hypochlorite treated dentin with composite resin.

Çelik et al stated that the effect of antioxidants also depends on the type of adhesive systems and their specific compositions. According to Ana Carolina et al use of sodium thiosulphate can significantly increase the bond strength of composite resin to NaOCl/EDTA-treated dentin, allowing adhesive restorations to be immediately applied after endodontic treatment.

The current study showed highest bond recovery when root dentin is treated with Sodium thiosulphate while lowest bond recovery is seen with root dentin treated with Gallic acid. Due to mild cytotoxic activity and formation of precipitation use of sodium thiosulphate is questionable, instead peracetic acid and Gallic acid can be used. 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.

V. Conclusion

- The bond strength of composite resin to sodium hypochlorite treated dentin is reduced because of potent biological oxidation of dentin.
- 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 1% Peracetic acid and 10% Gallic acid when used as reducing agent.
- Use of Anti-oxidant improve the shear bond strength of the pulp chamber dentin altered due to endodontic irrigant. Hence, possesses great potential in its clinical implication.

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