Sodium Thiosulfate for Recovery of Bond Strength to Dentin Treated with Sodium Hypochlorite

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Abstract

Introduction: The aim of this study was to evaluate the efficacy of sodium thiosulfate ($Na_2S_2O_3$) for restoring adhesion to pulp chamber dentin treated with sodium hypochlorite (NaOCl) and EDTA. **Methods:** Sixty-three crowns of bovine incisors were cut to expose the dentin pulp chamber. The specimens were polished and randomly distributed into 9 groups (n = 7) according to the following protocols used: 0.9% sodium chloride for 30 minutes (negative control), 5.25% NaOCl for 30 minutes, 17% EDTA for 3 minutes, and 5.25% NaOCl for 1 minute (positive control). The other groups, after treatments with NaOCl and EDTA, were immersed in 0.5% or 5% $Na_2S_2O_3$ for 1, 5, and 10 minutes or just immersed in an inert solution for 10 minutes (0.9% sodium chloride). After drying the specimens, Scotchbond Multi-Purpose (3M ESPE, St Paul, MN) was applied to the pulp chamber dentin followed by Filtek Z250 composite (3M ESPE). Six rectangular slabs were obtained from each specimen, and the dentin/resin interface was tested by using a universal testing machine. The resulting data were submitted to 1-way analysis of variance and the Duncan test (P = .05). **Results:** There was a significant decrease in bond strength regarding NaOCl and EDTA (P < .05). When 5% $Na_2S_2O_3$ was used for 10 minutes, the bond strength was found to be statistically equal to the negative control and higher than the positive control (P < .05). **Conclusions:** The use of $Na_2S_2O_3$ can significantly increase the bond strength of composite resin to NaOCl/EDTA-treated dentin, allowing adhesive restorations to be immediately applied after endodontic treatment. *(J Endod 2016;42:284–288)*

Key Words

Antioxidant agent, bond strength, sodium hypochlorite, sodium thiosulfate

Effective cleaning and shaping of the root canal as well as creation of an apical seal are essential goals for successful endodontic treatment (1). However, the immediate sealing of endodontically treated teeth using restorative materials is a powerful tool in preventing early coronal leakage (2–4) and was significantly associated with healthy apical tissues (5–7). Composite resin–based materials have been suggested for the restoration of nonvital teeth (8) because of their benefits, such as bonding to dentin by the hybrid layer and reduced marginal leakage (2, 9). Furthermore, teeth restored with resin composite show better fracture resistance than those restored with amalgam (8, 10) because their physical-mechanical properties are closer to those of dentin (11).

Nevertheless, chemical substances used during biomechanical preparation of root canals may change the structure of the dentin surface (12) and affect the interaction with adhesive restorative materials (13, 14). Sodium hypochlorite (NaOCl) is widely used as a chemical irrigant for endodontic therapy because of its antimicrobial activity and ability to dissolve organic matter (15), but the adverse effects of irrigants (eg, NaOCl and peroxides) on the resin-dentin bond strength have been investigated and previously confirmed (13, 14, 16–18). One of the reasons is that the remnants and oxidation by-products of NaOCl exhibit a negative effect on the polymerization of dental adhesive systems (16–18). On the other hand, the compromised bond strength to NaOCl-treated dentin could be restored by the application of an antioxidant solution before the adhesive procedure, resulting in neutralization and reversal of the oxidizing effect of NaOCl treatment on the dentin surface (18–21).

Sodium ascorbate is the most studied antioxidant agent (18–22). However, this solution shows a short shelf life because it is difficult to preserve the ascorbic acid solution in its original condition for a long period of time (22). Therefore, there is interest in evaluating new substances to achieve neutralization of oxidative compounds coming from NaOCl, thus overcoming the limitations of sodium ascorbate. Sodium thiosulfate ($Na_2S_2O_3$) is an antioxidant that has been used in medicine (23) and as a neutralizing agent of NaOCl in microbiological analysis (24, 25), showing potential to be used as reducing agents for NaOCl-treated dentin without damaging biological tissues.

Based on the importance of coronal sealing right after the conclusion of endodontic treatment, this *in vitro* study aimed to evaluate the antioxidant efficacy of $Na_2S_2O_3$ at different application times and concentrations on the recovery of the microtensile bond strength to pulp chamber bovine dentin treated with NaOCl and EDTA. The null hypothesis was that neither application times nor different concentrations of $Na_2S_2O_3$ would be effective in reversing the bond strength to dentin compromised by NaOCl and EDTA.

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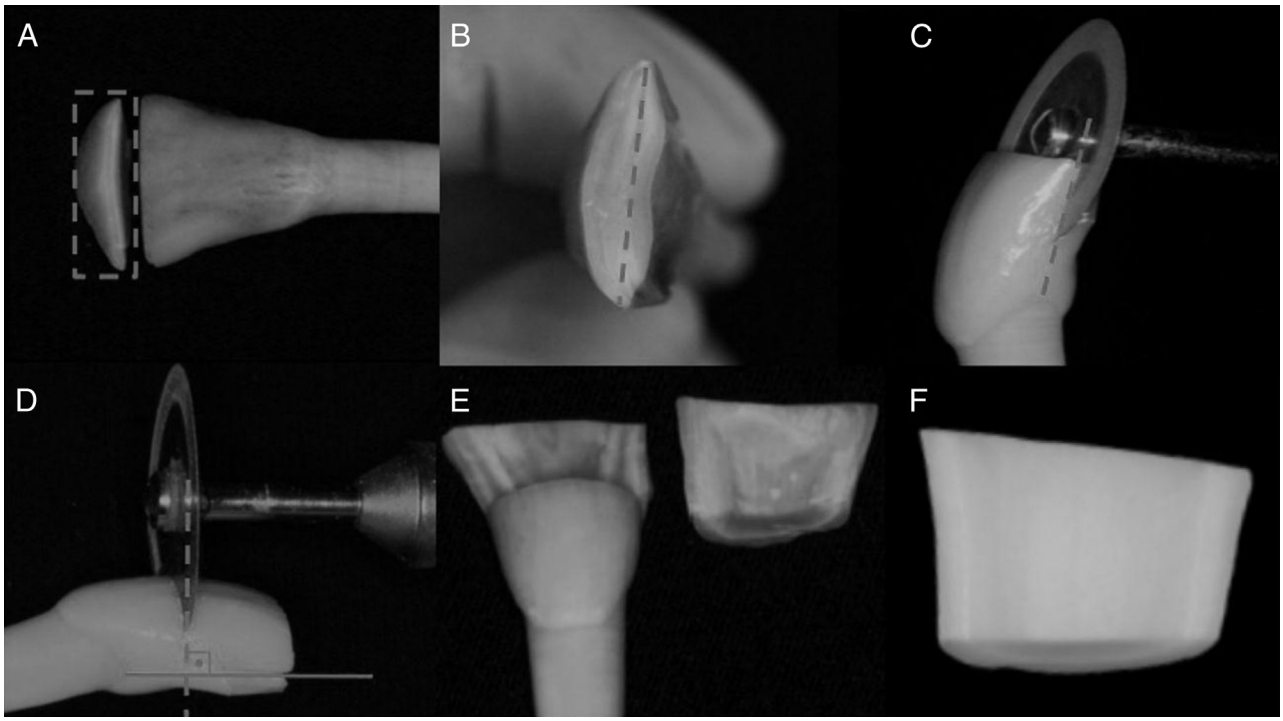

Figure 1. Specimen preparation. (*A*) Three to 5 mm were removed horizontally from the incisal portion with a double-sided diamond disc. (*B*) Incisal view delimitating the site of penetration of the disc into the second cut. (*C*) Depth of penetration was determined by placing the mandrel in the tooth. (*D*) The last cut was made perpendicularly to the long axis of the tooth. (*E*) The intracoronary dentin area of the buccal middle third of the crown. (*F*) The standardized dentin surface.

Materials and Methods

Specimen Preparation

Sixty-three bovine incisors were stored in 0.2% thymol and used within 6 months after extraction. Bovine dentin has been used in several studies, and this research used a similar methodology to that in the literature (13). The crowns were cut to expose the dentin area of the buccal middle third, with the incisal portion being removed horizontally with a double-sided diamond disc (KG Sorensen, Barueri, SP, Brazil) under running water (Fig. 1*A*). Next, the disc penetrated the dentin area centrally and longitudinally (Fig. 1*B*). The depth of penetration was determined by placing the mandrel in the tooth (Fig. 1*C*). Then, a last buccal section was made 10 mm from the incisal edge perpendicular to the long axis of the tooth. In this section, the disc penetrated until reaching the cut previously made (Fig. 1*D*), and the pulp tissue was carefully extracted with a spoon excavator. Next, the resulting slabs of intracoronary dentin (Fig. 1*E*) were flattened with 180-grit and 600-grit SiC papers under running water for 30 seconds to standardize the smear layer of the dentin surface (Fig. 1*F*).

The specimens were randomly divided into 9 groups according to the chemical irrigants used; namely, the negative control (NC) group did not receive treatment with NaOCl/EDTA, whereas the other groups were immersed in 5 mL 5.25% NaOCl for 30 minutes, with the solution being renewed every 10 minutes before immersion in 5 mL 17% EDTA for 3 minutes followed by a final washing with NaOCl for 1 minute. Next, the antioxidant protocol was performed with immersion in 5 mL 0.5% and 5% $Na_2S_2O_3$ solution for 1, 5, or 10 minutes according to the respective groups. The positive control (PC) was immediately bonded after treatment with NaOCl/EDTA (Table 1). The specimens of the NaOCl/10-minute group were immersed only in 5 mL 0.9% sodium chloride (NaCl) for 10 minutes without antioxidant treatment after treatment with NaOCl/EDTA.

Bonding Procedure

Before the bonding procedures, all specimens were dried with absorbent papers and etched with 37% phosphoric acid for 20 seconds. A total etching adhesive system (Scotchbond Multi-Purpose; 3M ESPE, St Paul, MN) was applied to the surface of the pulp chamber dentin according to the manufacturer's instructions. Three layers with 1 mm of a resin composite (Filtek Z250, 3 M/ESPE) were incrementally added to the bonded dentin (26), and each one was light cured for 20 seconds by

TABLE 1. Division of the Experimental Groups

Groups	Irrigation protocol	Antioxidant procedure	
Negative control	0.9% NaCl for 30 min	No	Immediately after, the adhesive protocol was performed in the dentin surface and built the composite resin blocks.
Positive control	5.25% NaOCl for 30 min + 17% EDTA for 3 min + 5.25% NaOCl for 1 min	No	
Tio 0.5/1 min		0.5% $Na_2S_2O_3$ for 1 min	
Tio 0.5/5 min		0.5% $Na_2S_2O_3$ for 5 min	
Tio 0.5/10 min		0.5% $Na_2S_2O_3$ for 10 min	
Tio 5/1 min		5% $Na_2S_2O_3$ for 1 min	
Tio 5/5 min		5% $Na_2S_2O_3$ for 5 min	
Tio 5/10 min		5% $Na_2S_2O_3$ for 10 min	

NaCl, 0.9% sodium chloride (pH = 6.3); NaOCl, 5.25% sodium hypochlorite (pH = 12.0); $Na_2S_2O_3$, sodium thiosulfate (0.5% pH 7.2; 5% pH 8.2).