Effect of Ascorbic Acid on Bond Strength of Resin-based Sealer to Root Canal Dentin (An In Vitro study)

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The aim of this study was to evaluate the effect of ascorbic acid on push-out bond strength of resin-based sealer (EndoRez) to root canal dentin after using two root canal irrigation regimens.

A total of fifty human single-rooted teeth were used in this study. Teeth were decoronated, cleaned and shaped using crown down technique. Samples were divided into five groups (10 each) according to the final irrigation protocol. In group I, samples were irrigated using saline (NaCl) for 10 minutes; group II, 5.25% NaOCl for 10 minutes; group III, 5.25% NaOCl for 10 minutes followed by 10% ascorbic acid for 10 minutes; group IV, 5.25% NaOCl for 10 minutes followed by 17% EDTA for 1 minute; group V, 5.25% NaOCl for 10 minutes followed by 17% EDTA for 1 and 10% ascorbic acid for 10 minutes.

The teeth were obturated using EndoRez sealer by lateral compaction technique. The bond strength was evaluated using the push-out test. The failure mode was analyzed using digital microscope for all the tested samples.

Results of the bond strength showed that Group V (NaOCl, EDTA and ascorbic acid) recorded the highest bond strength followed by group III (NaOCl and ascorbic acid), followed by group IV (NaOCl and EDTA), and followed by group I (saline). The lowest bond strength was recorded with group II (NaOCl).

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Cleaning and shaping of root canal system is considered an important step in endodontic treatment. Mechanical instrumentation alone is not effective in reducing bacterial load, but should be complimented with irrigation to further eliminate microorganisms. Different irrigating solutions and protocols have been proposed to disinfect the root canal system. Sodium hypochlorite is the most commonly used endodontic irrigant because of its antimicrobial and tissue dissolving properties. It causes alterations in cellular metabolism in microorganisms and destruction of phospholipids and degradation of lipids and fatty acids.

Its oxidative action causes deactivation of bacterial enzymes. However, being a strong oxidizing agent, it generates an oxygen rich layer on the dentin surface that results in reduced bond strength [(1)]. This oxygen rich dentin surface is probably an important reason for the low bond strength reported for adhesive resin sealers.

The bond strength of root canal sealers to dentin is important for maintaining the integrity of the seal in root canal filling in both static and dynamic situations. Additionally, increased adhesive properties to dentin may lead to greater strength of the restored tooth, which may provide greater resistance to root fracture and clinical longevity of an endodontically treated tooth.

It is possible to achieve normal, high bond strengths to radicular dentin under ideal conditions, as opposed to the low bond strengths reported for adhesive endodontic sealers[(2)]. One possible solution to this problem is the application of a reducing agent to the dentin after sodium hypochlorite irrigation. Reducing agents such as ascorbic acid and sodium ascorbate are reported to reverse the negative effects of sodium hypochlorite.

Over the years several materials have been proposed as root canal irrigants. Each and every one of these agents can result in chemical and physical changes to root canal dentin. Bonding to root canal dentin can be challenged by the type of irrigant used.

(I) Effect of irrigants on the bond strength to dentin:

Gettlemen et al [3] studied the influence of a smear layer on the adhesion of sealer to dentin. One hundred and twenty extracted human anterior teeth were used in this study. The teeth were split longitudinally, and the internal surfaces were ground flat. One-half of each tooth was left with the smear layer intact, while the other half had the smear removed by washing for 3 min with 17% EDTA followed by 5.25% NaOCl. Using a specially designed jig, the sealer was placed into a 4-mm wide x 4-mm deep well which was then set onto the tooth at a 90^{o} angle and allowed to set for 7 days in 100% humidity at 37^{o}C. The set-up was subjected to a tensile load and the bond strength values were recorded. The results showed significant differences among AH26, Sultan, and Sealapex, with AH26 being the strongest and Sealapex being the weakest. The only significant difference with regard to the presence or absence of the smear layer was found with AH26, which had a stronger bond when the smear layer was removed.

Vargas et al [4] investigated the effect of a 2-minute exposure of 5% sodium hypochlorite (NaOCl) on the shear bond strength for two adhesive systems and the ultrastructure of the resin-dentin interface under SEM. Twenty eight extracted human third molars were used in this study. Their mesial and distal surfaces were ground to expose dentin. Teeth were randomly assigned to four groups according to the type of surface treatment and the adhesive system used. G1; Scotchbond Multi-Purpose (SBMP), G2; SBMP/ NaOCl where the surfaces were treated with 5% NaOCl for 2 minutes after acid conditioning, G3; All-Bond 2 (AB2) and G4; AB2/NaOCl. The results showed that a 2-minute exposure of dentin to 5% NaOCl following acid conditioning of the dentin had no significant effect on the dentin shear bond strength for Scotchbond Multi-Purpose, but significantly increased the bond strength of All-Bond 2 specimens.

Nikaido et al [5] evaluated the bond strengths of three different types of resin bonding systems to teeth prepared for endodontic treatment. Access cavity preparation and removal of pulp tissues were performed in bovine incisors. The teeth were divided into three experimental groups and one control group according to the type of irrigant used. G1; The root canals were irrigated with saline (control), G2; 5% sodium hypochlorite, G3; 3% hydrogen peroxide and G4; combination of both for 60 seconds. The tensile

bond strength values were measured using a universal testing machine. Results showed that single bond and super bond C&B had statistically lower bond strengths in the experimental groups compared with the control groups. Clearfil liner bond II self-etching bonding system was the least affected by chemical irrigants used.

Saboia et al [6] evaluated the effect of collagen removal on the shear bond strength and hybrid layer ultra-morphology for two single-bottle adhesive systems. The buccal and lingual surfaces of 80 extracted human third molars were ground to expose dentin. Teeth were randomly assigned to four groups and received the following treatments: G1(P&B 2.1); Prime & Bond 2.1 adhesive was applied according to the manufacturer's directions and Restorative Z100 composite resin was bonded to the dentin surface, G2 (P&B 2.1/NaOCl); the same procedures were followed as for G1 except that the surfaces were treated with 10% sodium hypochlorite (NaOCl) for one minute after acid conditioning, G3 (SB); Single Bond was applied according to the manufacturer's recommendations, G4 (SB/NaOCl); the same procedure was followed for G2, using Single Bond. The results showed that a one-minute exposure of dentin to 10% NaOCl following acid conditioning resulted in a significant increase of the dentin shear

bond strength for Prime & Bond 2.1 but resulted in a significant reduction in bond strength with single bond.

Perdigão et al [7] studied the effect of 10% NaOCl gel on the dentin shear bond strengths and hybrid layer ultra-morphology of two dentin adhesives. Eighty bovine incisors were used in this study. The labial surface was polished to expose middle dentin. The specimens were randomly assigned to two groups according to the type of adhesive used either Prime & Bond NT or Single Bond. After rinsing off the etchant, one drop of 10% NaOCl was applied to the etched dentin surface and left for 0 (control), 15, 30, or 60 s. The gel was rinsed off with water and the dentin adhesive and composite resin was applied. After 24 h in water at 37^0C, the specimens were thermocycled and the shear bond strengths measured. The results showed that the increase in the NaOCl application time resulted in a progressive decrease in shear bond strengths for both dentin adhesives.

Frankenberger et al [8] compared the dentin bond strength and marginal adaptation of direct composite resins with and without additional NaOCl treatment after the etching process. A total of 150 cavities were prepared into dentin disks and filled with direct composite resins. Dentin adhesives of the fourth and fifth generations were used in combination with corresponding