The effect of four different irrigating solutions on the shear bond strength of endodontic sealer to dentin – An In-vitro study

J Ravikumar¹, V Bhavana¹, Chandrashekar Thatimatla¹, Satyanarayana Gajjarapu¹, S Ganesh Kumar Reddy², B Rahul Reddy³

Contributors:
¹Assistant Professor, Department of Conservative Dentistry & Endodontics, Drs. S & NR Siddhartha Institute of Dental Sciences, Chinaoutpally, Gannavaram, Andhra Pradesh, India; ²Assistant Professor, Department of Conservative Dentistry & Endodontics, Sri Sai College of Dental Surgery, Vikarabad, Andhra Pradesh, India; ³Assistant Professor, Department of Public Health Dentistry, Lenora Institute of Dental Sciences, Rajahmundry, Andhra Pradesh, India; ⁴Reader, Department of Periodontics, Lenora Institute of Dental sciences, Rajahmundry, Andhra Pradesh, India; ⁵Professor, Department of Oral & Maxillofacial Surgery, Priyadarshini Dental College, Thiruvallur, Tamil Nadu, India; ⁶Assistant Professor, Department of Prosthodontics, Sri Sai College of Dental Surgery, Vikarabad, Andhra Pradesh, India.

Correspondence:
Dr. J Ravikumar. Department of Conservative Dentistry & Endodontics, Drs. S & NR Siddhartha Institute of Dental Sciences, Chinaoutpally, Gannavaram - 521101, Andhra Pradesh, India.
Email: drkumarjanga@gmail.com

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Abstract:
Background: To evaluate the effect of EDTA, Maleic acid, Citric acid and MTAD Irrigating Solutions on the shear bond Strength of A-H plus sealer.

Materials & Methods: Forty mandibular single rooted premolar teeth with straight roots were taken, decoronated and instrumented using Protaper rotary instruments to size #F, 0.09 taper, at the working length, with 3 mL of 2.6% sodium hypochlorite in between irrigation. The teeth were divided into 4 groups and final irrigation was done using NaOCl/EDTA: Group 1 (Positive Control group); NaOCl/Maleic acid: Group 2; NaOCl/Citric acid: Group 3; NaOCl/MTAD: Group 4. Obturation was done using Obtura II thermoplasticized technique with AH Plus sealer. Each root section was then subjected to a compressive load via a universal testing machine, to measure the push out bond strength.

Results: The data was collected and submitted to statistical analysis by One way ANOVA test, and Group 2: NaOCl/Maleic acid showed greater bond strength (6.542+/- 1.12 MPa) than other groups.

Conclusion: Removal of smear layer with Maleic acid as a final rinse enhanced the adhesive ability of A-H plus sealer, followed by EDTA, Citric acid and MTAD. A final rinse with MTAD might have a negative effect on the bonding ability of resin-based A-H plus sealer.

Key Words: A-H plus sealer, bond strength, irrigation, maleic acid, MTAD

Introduction
Endodontic treatment plays an important role in achieving and maintaining good oral health by eliminating infection and preserving natural dentition. Root canal treatment is affected by clinical factors such as effective biomechanical instrumentation of the root canal to produce a debris free surface, disinfection and dissolution of organic matter to eliminate bacterial pathogens and a three dimensionally sealed and obturated canal.¹ The tooth is retained longer only when there is excellent synergy between restorative and endodontic treatment.

The use of EDTA and sodium hypochlorite (NaOCl) alternately has been proved efficient in removing endodontic smear layer for many years. But the major drawback is that they lack sustained antimicrobial capacity.² Some of the adhesive systems use 10% Maleic acid, a mild organic acid, as a dentin conditioner to remove the smear layer.³ Ballal et al. reported that final irrigation with 7% maleic acid for 1 min was more efficient than 17% EDTA in the removal of smear layer from the apical third of the root canal system.⁴ Many studies also reported the use of citric acid as an irrigating solution, as it has been found to possess the smear layer removing quality when used as an acid etchant in restorative dentistry.⁵

The introduction of MTAD, represents a clinical effective endodontic irrigation technique. When MTAD is used as directed, it is proven to effectively remove the smear layer with less erosion to the dental structure than EDTA, without any adverse effects on flexure strength and modulus of elasticity of dentin.⁶ Adhesion was found to be a very desirable physical property in root canal cements. Ideal endodontic sealer should seal the root canal space and should adhere to both the gutta-percha core and root canal wall. Epoxy resin-
Effect of irrigating solutions on shear bond strength...Ravikumar J et al


based sealer cements such as AH Plus sealer (Dentsply, Germany) have been widely accepted because of their good physical properties, reduced solubility, apical sealability, adequate biological performance and microporosity to root dentin. Only a few studies have investigated the degree of bonding and adaptation of AH plus sealer to root canal dentin, but to date no study has determined the effect of Maleic acid and Citric acid irrigants on the sealer-dentin bond strength when using the AH plus sealer for obturation. Therefore, the aim of this study was to evaluate the effect of EDTA, Maleic acid, Citric acid and MTAD irrigating solutions on the shear bond Strength of A-H plus sealer.

Materials and Methods
Forty freshly extracted mandibular single rooted premolar teeth with straight roots were taken and thoroughly cleaned by removing the hard deposits using curettes and the soft deposits by soaking in NaOCl 5.25% for 30 minutes and then stored in distilled water. Before instrumentation, the teeth were decoronated using a high-speed carbide bur and water spray to obtain approximately 10-mm long root segments. Canal patency and working length were established by inserting K file #15 (Mani, Inc, Tochigi, Japan). The root canals were instrumented using Protaper nickel-titanium rotary instruments (Dentsply, Germany). Each canal was enlarged to size #F3, 0.09 taper, at the working length. Irrigation with 3 mL of 2.6% sodium hypochlorite was performed between each file size. The roots were then randomly divided into four groups (n= 10) according to the final irrigation regimen: Group 1(Positive Control group), 5 mL of freshly prepared 17% EDTA; Group 2, 5 mL of freshly prepared 7% Maleic acid; Group 3, 5 mL of freshly prepared 10 % Citric acid; and Group 4, 5 mL MTAD (Biopure, Dentsply Tulsa Dental, Tulsa, OK) Figure 1. The canals were dried using corresponding protaper paper points (Dentsply, Germany). All the root canals were filled using warm gutta-percha and AH plus root canal sealer (Dentsply, Germany). After mixing the sealer, the sealer was applied along the walls of the canals using lentulo spiral and also gutta-percha protaper master cone # F3 (Dentsply, Germany) was lightly coated with sealer and inserted to the working length. A System B pluggage size fine medium (SybronEndo Europe) was used to condense the master cone to within 5 mm from the working length, to avoid voids. The coronal and middle thirds of the canals were then filled using Obtura II thermoplasticized technique at 185°C (Spartan/Obtura, Fenton, MO), to improve the homogeneity, accuracy and surface adaptation of Gutta percha. The roots were coded and placed in 100% humidity for 48 hours to ensure complete setting of the sealers. Each root was then embedded in epoxy resin in a custom-made split-ring copper mold. After setting of the epoxy resin, three horizontal sections of 2-mm thickness each were cut from coronal, middle and apical thirds of each root by using a water-cooled precision saw. Each root section was then subjected to a compressive load via a universal testing machine (Hyderabad Central University, India) at a crosshead speed of 1 mm/min using a 0.8-mm diameter stainless steel cylindrical plunger, Figure 2. The push-out force was applied in an apicocoronal direction until bond failure occurred. Data were presented as mean and standard deviation values, and statistical analysis was done using one way ANOVA test, using SPSS version 14.0 software.

Results
The mean values of bond strengths recorded for different groups are presented in Table 1 and Figure 3. Group 2 (NaOCl/Maleic acid/AH Plus) yielded significantly the highest mean push-out bond strength (6.542+/_- 1.12 MPa). On the other hand, the significantly lowest mean...
Effect of irrigating solutions on shear bond strength...Ravikumar J et al

Table 1: Mean values of bond strengths for different groups.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Mean shear bond strength (MPa +/- SD)</th>
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<tbody>
<tr>
<td>1. NaOCl/EDTA</td>
<td>5.431 +/- 1.028</td>
</tr>
<tr>
<td>2. NaOCl/Maleic acid</td>
<td>6.542 +/- 1.12</td>
</tr>
<tr>
<td>3. NaOCl/Citric acid</td>
<td>4.149 +/- 0.468</td>
</tr>
<tr>
<td>4. NaOCl/MTAD</td>
<td>1.107 +/- 0.459</td>
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</table>

Discussion

Surface treatment of dentin with various irrigants may cause changes in the structural and chemical composition of dentin, thereby changing its solubility and permeability characteristics, therefore affecting the adhesion of materials to the dentinal surface. Close contact between the adhesive material and the substrate is necessary for good adhesion as it facilitates molecular attraction and allow either chemical adhesion or penetration for micromechanical surface interlocking.

In the current study, the bond strength of the tested obturation system was found to be differently affected by different final irrigation solutions applied. In this study, Maleic acid as a final irrigant showed highest bond strength with AH plus sealer (6.542 +/- 1.12 MPa), it may be due to Maleic acid is highly acidic, it has a better demineralizing effect within a shorter period of time, hence completely removing the smear layer, creating efficient microretention between the dentinal tubules and the AH plus sealer. When 17% EDTA was used as a final irrigant, the recorded push-out bond strength values of GP/AH plus agree with those reported by Sly et al. Final irrigation with EDTA resulted in higher bond strength values for AH plus than Citric acid and MTAD, this may be attributed due to, EDTA significantly decreased the wetting ability of dental wall (ie, decreased surface energy). Therefore, a suitable dentin substrate could be provided for the adhesion of materials with hydrophobic nature as the resinous AH plus.

The use of MTAD as a final irrigant with gutta-percha/AH plus resulted in a significant decrease in its bond strength (1.107 +/- 0.459 Mpa) compared with EDTA/AH plus and other groups. MTAD is acidic (pH = 2.15), containing doxycycline and citric acid among its constituents and resulting in the removal of the smear layer and demineralization of the underlying dentin. According to Tay et al, MTAD produced a 10- to 12-mm thick zone of demineralized dentin compared with only a 4- to 6-mm thick zone produced by EDTA. Furthermore, Tween 80 detergent, a constituent of MTAD, permitted increased wettability and dentin surface energy, therefore increasing intertubular dentin permeability as well as the exposure of collagen matrix and intertubular fluid, which could have negatively affected the adhesion of the hydrophobic AH plus sealer. The negative effect on the bond strength of MTAD may also be attributed due to red-purple degradation precipitate formation, due to oxidation of tetracycline in MTAD with NaOCl. This degradation product of tetracycline was found to be 4-alpha, 12-alpha-anhydro-4-oxo-4-dedimethylaminotetracycline (AODTC), which existed in its orange-yellow, protonated form at low pH.

Conclusion

It could be concluded that, within the limitations of this study:

1. Removal of smear layer with Maleic acid as a final rinse enhanced the adhesive ability of AH plus sealer, followed by EDTA, Citric acid and MTAD.
2. A final rinse with MTAD might have a negative effect on the bonding ability of resin-based A-H plus sealer.

References