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Original Research

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

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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_3, 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-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 microretention to root dentin.[2] 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 #$F_{3,}$ 0.09 taper, at the working length. Irrigation with 3 mL of 2.6% sodium hypochlorite was performed between each file size.

Figure 1: Final irrigation with MTAD.

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, Dentsplay 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 # F_3 (Dentsply, Germany) was lightly coated with sealer and inserted to the working length. A System B plugger 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.

Figure 2: Root section subjected to compressive load.

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 push-out bond (1.107+/_ 0.459 MPa) was recorded for Group 4 (NaOCl/MTAD/AH Plus). The remaining

Table 1: Mean values of bond strengths for different groups.	
Groups	Mean shear bond strength (MPa +/_ SD)
1. NaOCl/EDTA	5.431+/_ 1.028
2. NaOCl/ Maleic acid	6.542+/_ 1.12
3. NaOCl/ Citric acid	4.149+/_ 0.468
4. NaOCl/MTAD	1.107+/_ 0.459

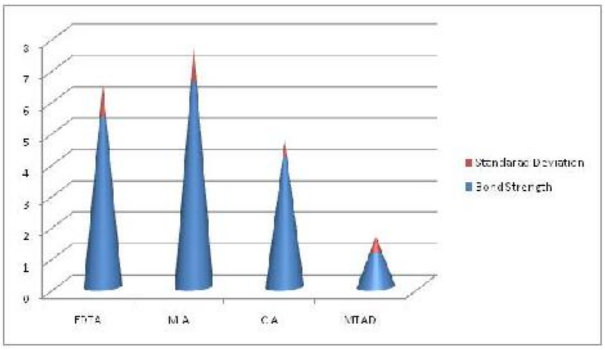

Figure 3: Graph representing mean values of bond strengths.

Groups revealed intermediate mean values of bond strength. No significant difference was found between Group 1 (NaOCl/EDTA/AH Plus): 5.431+/_ 1.028 MPa and Group 2 (NaOCl/Maleic acid/AH Plus): 6.542+/_ 1.12 MPa and Group 3 (NaOCl/Citric acid/AH Plus): 4.149+/_ 0.468 MPa, respectively.

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.[7] 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.[8]

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, Maliec 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,[9] 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.[10] 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 dentinal 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.[11]

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.[12] 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.[13,14]

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

1. Kandaswamy D, Venkateshbabu N, Arathi G, Roohi R, Anand S. Effects of various final irrigants on the shear bond strength of resin-based sealer to dentin. J Conserv Dent 2011;14(1):40-2.
2. Hashem AA, Ghoneim AG, Lutfy RA, Fouda MY. The Effect of Different Irrigating Solutions on Bond Strength of Two Root Canal–filling Systems. J Endod 2009;35(4):537-40.
3. Prabhu SG, Rahim N, Bhat KS, Mathew J. Comparison of removal of endodontic smear layer using NaOCl, EDTA, and different concentrations of maleic acid – A SEM study. Endodontology 2003;15:20-5.
4. Ballal NV, Kandian S, Mala K, Bhat KS, Acharya S. Comparison of the Efficacy of Maleic Acid and Ethylenediaminetetraacetic Acid in Smear Layer Removal from Instrumented Human Root Canal: A Scanning Electron Microscopic Study. J Endod 2009;35:1573–6.
5. Haapasalo M, Shen Y, Qian W, Gao Y. Irrigation in endodontics. Dent Clin North Am 2010;54:291–312.
6. Singh S, Krishna S, Acharya SR, Rao PS, Ballal V. Comparison of antimicrobial efficacy of biopure MTAD and 2.5% sodium hypochlorite irrigation in infected root canals following single visit endodontics - An in vivo study. Endodontology 2009;21(1):27-33.
7. Dogan H, Oalt S. Effects of chelating agents and sodium hypochlorite on mineral content of root dentin. J Endod 2001;27:578–80.
8. Erickson RL. Surface interactions of dentin adhesive materials. Oper Dent 1992;5:81–94.
9. Ballal NV, Kandian S, Mala K, Bhat KS, Acharya S. Comparison of the Efficacy of Maleic Acid and Ethylenediaminetetraacetic Acid in Smear Layer Removal from Instrumented Human Root Canal: A Scanning Electron Microscopic Study. J Endod 2009;35:1573–6.
10. Sly MM, Moore BK, Platt JA, Brown CE. Push-out bond of a new endodontic obturation system (Resilon/Epiphany). J Endod 2007;33:160–2.
11. Dogan Buzoglu H, Calt S, Gümüsderelioglu M. Evaluation of the surface free energy on root canal dentin walls treated with chelating agents and NaOCl. Int Endod J 2007;40:18–24.
12. Tay FR, Hosoya Y, Loushine RJ, Pashley DH, Weller RN, Low DC. Ultrastructure of intraradicular dentin after irrigation with BioPure MTAD. II. The consequence of obturation with an epoxy resin-based sealer. J Endod 2006;32:473–7.
13. Gopikrishna V, Venkateshbabu N, Krithikadatta J, Kandaswamy D. Evaluation of the effect of MTAD in comparision with EDTA when employed as the final rinse on the shear bond strength of three endodontic sealers to dentin. Aust Endod J 2011;37(1):12-7.
14. Tay FR, Mazzoni A, Pashley DH, Day TE, Ngoh EC, Breschi L. Potential Iatrogenic Tetracycline Staining of Endodontically Treated Teeth via NaOCl/MTAD Irrigation: A Preliminary Report. J Endod 2006;32:354 –8.