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Original Article

Evaluation of push-out bond strength of AH26 sealer using MTAD and combination of NaOCl and EDTA as final irrigation

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ABSTRACT

Background: During endodontic procedures, the smear layer is formed as a result of mechanical instrumentation of the canal. Combination of ethylenediamine tetraacetic acid (EDTA) and sodium hypochlorite (NaOCl) is widely used for removal of the smear layer. Application of Mixture of tetracycline, acid, and detergent (MTAD) as final irrigant subsequent to initial irrigation of 1.35% NaOCl has been proposed to increase clinical efficiency, biocompatibility and prolonged intra-canal antibacterial activity. Considering the importance of adhesion of endodontic sealers to the dentin walls of a prepared root canal, the present study evaluated push-out bond strength of AH26 sealer using final irrigation of MTAD and EDTA + NaOCl.

Materials and Methods: Sixty five single-rooted teeth were prepared endodontically with the same chemomechanical technique and were randomly divided into three groups based on their final irrigation regimen: 17% EDTA + 5.25% NaOCl group (n = 30), MTAD group (n = 30) and control group (n = 5). Obturation of the canals was performed with gutta-percha and AH26 sealer. All teeth were sectioned in order that two specimens of 1 mm thickness were obtained from the coronal and the middle one third of each root resulting in 60 specimens for each experimental group and 10 specimens for control group. For push-out test, universal-testing machine was used to exert a constant compressive apico-coronal load at a speed of 0.5 mm/min. Minimum amount of compressive load caused dislodgement was measured and converted into megapascal (MPa) scale. One-way analysis of variance and the *post hoc* Tukey test were used for statistical analysis of the data (α = 0.05).

Results: In MTAD group, mean micro-push-out bond strength of AH26 sealer to dentin walls was obtained 2.23 MPa compared to 2.0 MPa for EDTA + NaOCl group. The mean bond strength of AH26 sealer to dentin walls was significantly greater using MTAD compared with combination of EDTA and NaOCl or saline.

Conclusion: MTAD final rinse significantly increased micro-push-out bond strength of AH26 sealer to canal dentin walls compared with EDTA + NaOCl.

Key Words: AH26 sealer, EDTA, MTAD, push-out bond strength

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INTRODUCTION

According to the conventional wisdom, success of a root canal therapy depends on sufficient shaping, cleaning and obturating of the entire radicular space. Because of the inaccessible areas and irregularities of root canal system and therefore remnants of tissues, bacteria, and bacterial by-products existing in a prepared radicular space, even if root canal system was clinically and radiographically well-shaped and cleaned, obtaining an impervious seal would be essential to prevent leakage after a proper endodontic debridement.[1,2]

It is important to keep in mind that the dentin is porous and tubular and obtaining an impervious seal may not be feasible because of structure of dentin and

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canal irregularities. No material or technique thus, far had able to prevent leakage.[3]

One highly desirable feature of an ideal endodontic sealer is adhesion, which could effectively seal root canal space.[4]

The smear layer may adversely affect disinfection of dentin walls, while blocking irrigants from entering dentinal tubules;[3] In addition, it may increase post-obturation microleakage,[5-8] and may serve as a source of nutrients for some species of intra-canal microbiota.[9,10]

Decalcifying chelating agents are widely used to remove smear layer in contemporary endodontics. Stronger bond has been reported due to removal of the smear layer.[11] Endodontic chelators may detach biofilms adhering to root canal walls. This may explain why an EDTA irrigant is highly superior to saline in reducing intra-canal bacteria despite its relatively limited antiseptic capacity.[12] Microbiologic studies revealed that early removal of smear layer resulted in significantly higher bacterial counts.[13] It seems more beneficial to remove this layer in later phases of endodontic treatment rather than earlier ones.

EDTA is normally used in a concentration of 17%; a solution with a neutral pH that endodontists have used as a canal irrigant.[14] Researchers reported that EDTA was able to selectively remove mineral from a dentin surface, exposing a collagenous matrix.[14,15] EDTA alone cannot remove smear layer effectively; a proteolytic component (e.g., NaOCl) must be added for removing organic components.[16] Grawehr *et al*.[17] reported that EDTA retained its calcium-complexing ability when mixed with NaOCl, but EDTA caused NaOCl to lose its tissue-dissolving capacity, with virtually no free chlorine detected in the combination. This suggests that EDTA and NaOCl should be used separately in clinical use and copious amounts of NaOCl should be administered to wash out remnants of the EDTA.

MTAD is the first endodontic irrigant, which is able to both remove mineral part of smear layer and disinfect root canal space. MTAD is a mixture of 4.25% citric acid, 3% doxycycline hyclate, and, 0.5% Tween 80.[18] In clinic, MTAD has been recommended as a final rinse after completion of routine chemomechanical preparation.[19-21] Both doxycycline and citric acid have been separately reported as being capable of removing smear layer.[22] Irrigation solutions with a low surface tension are more suitable for endodontics.[23] This is the reason for addition of Tween 80 to MTAD.

Although, efficacy of MTAD and EDTA for smear layer removal was confirmed, but no significant difference between these two solutions was reported.[24,25]

Aim of the present study is to evaluate push-out bond strength of AH26 sealer to root canal dentin with a micro-push-out technique subsequent to a final irrigation of MTAD compared with combination of NaOCl/EDTA.

MATERIALS AND METHODS

Sixty five recently extracted human single-rooted teeth that did not have any previous endodontic treatment or signs of root resorption or caries were used for this *ex vivo* study.

For disinfecting, external surface of all teeth were planned with periodontal curettes and then all of them were immersed in 5.25% sodium hypochlorite for 30 min. After mentioned process, teeth were kept in 0.9% sterile normal saline at room temperature.

All of the anatomical crowns of the teeth were removed at the cementoenamel junction (CEJ) level and perpendicular to the long axis of the root, using a nonstop machine and diamond disc with copious amounts of water as coolant. Obtained roots were negotiated with #10 and #15 K- files (MANI Inc, Japan) to ensure patency. For each tooth, pre-flaring was carried out with passively using #2, #3, #4 Gates Glidden (MANI Inc, Japan) burs without exerting any lateral pressure. Subsequently, 0.04 and 0.06 taper - FlexMaster nickel titanium rotary files (VDW GmbH, Munich, Germany) and K-file hand instruments were used to complete crown-down preparation in order to #40 hand file could be placed at working length as a master apical file. During preparation of each canal, recapitulation and 5 ml NaOCl irrigation were carried out following use of each instrument.

All teeth were randomly divided into MTAD group (n = 30), NaOCl/EDTA group (n = 30) and control group (n = 5). In MTAD group (Dentsply Tulsa Dental, Tulsa, OK), 5 ml of 1.3% NaOCl was used as endodontic irrigant between each instrument and according to the MTAD protocol a 5 ml final rinse of MTAD was performed (4 ml rinse following 1 ml remaining in root canal for 5 min). In NaOCl/EDTA group, teeth were irrigated with 5 ml of 17% EDTA (for 1 min) subsequent to a 5 ml irrigation of 5.25% NaOCl. In the control group, teeth received 5 ml sterile normal saline as final irrigant. Irrigation was performed

using a 5 ml disposable plastic syringe (Supa, Iran) with 25-guage needle passively placed up to 2 mm from the working length without binding.

Finally, each prepared canal was dried with paper points. AH26 sealer (Dentsply Caulk, Germany) was applied into canal introducing a lentulo spiral (Maillefer, Ballaigues, Switzerland) prior to the obturation. Cold lateral compaction technique was used for obturation of canal space.

All teeth were stored in 100% humidity at 37°C for 24 h. Subsequently, teeth were sectioned perpendicular to the long axis of the root using a high-speed thin sectioner machine under copious water coolant in order that two specimens of 1 mm-thickness were obtained from coronal and middle thirds of each tooth, resulting in 60 specimens for each experimental group and 10 specimens for control group**.**

Universal-testing machine (Zwick/Roell, Z020, Germany) with a 0.84-mm diameter stainless steel cylindrical plunger and exerting a constant compressive apico-coronal load at a speed of 0.5 mm/min, was used for push-out test. The plunger was positioned so as not to contact with root canal walls. The minimum amount of compressive load leading to dislodgement of the endodontic sealer was measured and recorded for each specimen in MPa scale.

Normal distribution of the data was confirmed using Kolmogorov-Smirnov Z test ($P < 0.05$). One-way analysis of variance was used for mean micro-push-out bond strength. If one-way analysis of variance were significant, then *post hoc* Tukey test would use for pair-wise comparison. Significance level was set at $P \leq 0.05$ and SPSS 11.5 software (SPSS Inc, Chicago, IL) was used for statistical analysis of the data.

RESULTS

Adhesion to canal dentin wall was measurable for all of specimens. None of samples had premature failure. Mean bond strength values (± SD) of different groups presented in Table 1. One-way ANOVA revealed a significant influence of irrigation regimen on push-out bond strength values ($P < 0.05$).

Push-out bond strength of both MTAD and NaOCl/EDTA was significantly greater than that of saline ($P < 0.05$). Between MTAD and EDTA, push-out bond strength was significantly higher for MTAD ($P = 0.004$). Figure 1 shows mean bond strength values and standard deviation for experimental and control groups.

Table 1: Mean micro-push-out bond strength, standard deviation, and total number of specimens for each group

Group	Mean (MPa)	SD (MPa)	*N*
EDTA+NaOCl	2.0018	0.39611	60
MTAD	2.2335	0.38224	60
Control	0.8000	0.16313	10

EDTA: Ethylenediamine tetraacetic acid; MTAD: Mixture of tetracycline acid, and detergent; MPa: Megapascal; SD: Standard deviation

DISCUSSION

In the field of smear layer management, the conflicting results of the studies could arise from the different methodologies, and study designs. Although, majority of researchers reported that removal of smear layer improved bond strength of endodontic sealers to dentin walls,[11,12,25-27] some have suggested the converse that remaining of smear layer enhanced shear bond strength of sealer.[28]

Combined use of NaOCl and EDTA was reported the most effective approach for smear layer removal.[29] Although NaOCl is able to remove organic components of smear layer, this removal is totally inconsiderable during root canal preparation.[3,30] In the present study, full strength NaOCl (in combination with EDTA) was used to gain maximum efficacy of the agent for dentin conditioning and removal of organic components of smear layer.

In this study, NaOCl/EDTA final irrigation protocol significantly increased push-out bond strength compared with saline. This finding agrees with reports of Zmener *et al*.[31] and Tagger *et al*.,[32] which could be attributed to resin penetration into dentinal tubules creating efficient micro-retention.

Shokouhinejad *et al*.[33] reported increased AH26 bond strength using NaOCl/EDTA compared to MTAD. However, the present study revealed significantly higher push-out bond strength for MTAD than EDTA. Such a different result may be due to different fine details between two studies. Shokouhinejad *et al*. used sealer coated gutta-percha master cone and roots' middle one third specimens to evaluate AH26 bond strength. The contrary, in this study endodontic sealer was introduced into canals using lentulo spiral and specimens were obtained from both middle and coronal one third of roots. Kahn[34] reported that

lentulo was the most effective method of sealer placement. In addition, according to Neelakantan *et al.*[35] bond strength decreased in corono-apical direction which could be result of root dentin anatomy and it's less patent tubules in apical direction.[36]

It has been demonstrated that EDTA reduced wetting ability of dentin[37] and Hashem *et al.*[38] suggested the premise that it may provide suitable dentin surface for adhesion of an hydrophobic epoxy resin-based sealers. Moreover, lower bond strength for MTAD was blamed on increased wetting ability of dentin due to the presence of Tween 80. Despite their presumption, Wachlarowicz *et al.*,[39] De-Deus *et al.*[40] showed similar push-out bond strength of Resilon/Epiphany (hydrophilic resin based sealer) after smear layer removal following either EDTA or MTAD final rinse.

In the present study MTAD showed the greatest bond strength values than others. This finding may depend on the fact that bond strength of an epoxy resin sealer to dentin is related to formation of covalent bonds between epoxide rings and exposed amino groups in collagen network.[41] Because of lower concentration of NaOCl, MTAD may preserve more collagen matrix to provide greater push-out bond strength than EDTA.

Mortazavi *et al.*[42] reported that clinical protocol of MTAD (1.3% NaOCl as a root canal irrigant and a 5-min application the agent as a final rinse) no adverse effect on the shear bond strength of self-etch adhesives to dentin.

Goracci *et al.*[43] expressed that push-out technique was more reliable and precise than the micro-tensile technique for measurement of bond strength to dentin and should be run to suit the convenience of providing specimens and statistical analysis. In the present study, push-out bond strength was measured and with providing 1-mm thick specimens, probability of non-uniform stress distribution was eliminated.[44]

CONCLUSION

Regarding the limitations of this study, the results imply that smear layer removal improved bond strength of AH26 sealer to root canal walls and this improvement is statistically greater with application of MTAD as a final rinse to that of combination of NaOCl and EDTA final rinse. The minimum value of push-out bond strength of AH26 sealer belonged to saline final rinse, which suggest that NaOCl alone irrigation during canal preparation was insufficient for smear removal and providing adhesion.

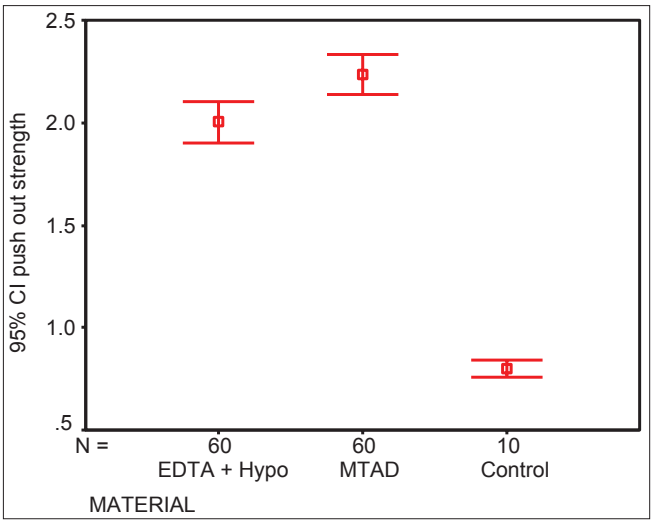

Figure 1: The histogram of the mean bond strength values and standard deviation of the groups

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