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Araştırma/ Research Article

INFLUENCE OF DIFFERENT FINAL ROOT CANAL IRRIGATION REGIMENS ON THE PUSH-OUT BOND STRENGTH OF AH PLUS

SON YIKAMADA KULLANILAN FARKLI KÖK KANAL SOLÜSYONLARININ AH PLUS PAT İN İN BAĞLANMA DAYANIMI ÜZERİNE ETKİLERİNİN İNCELENMESİ

Dr. Dt. Emel UZUNOĞLU* **Yrd. Doç. Dr. Sevinç AKTEMUR TÜRKER****
Dr. Sevilay KARAHAN***

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ABSTRACT

Aim: To evaluate influence of different final irrigation regimens on bond-strength of epoxy resin based sealer (AH Plus).

Material and method: Forty-eight mandibular incisors were irrigated with 2.5% sodium hypochlorite during and after completion of root canal preparation. Roots were divided into 4 groups (n = 12) according to the final irrigation regimens: Group 1: 5 mL 17% ethylenediaminetetraacetic acid (EDTA); Group 2: 5 mL 17% EDTA followed by 5 mL 2% chlorhexidine gluconate (CHX); Group 3: 5 mL QMix; and Group 4: 5 mL distilled water as control. All specimens were filled with gutta-percha (GP) and AH Plus. One-millimeter thick four horizontal sections from each root were sliced for bond-strength measurement. Data were statistically analyzed by one-way Anova and Bonferroni tests ($p<0.05$).

Results: Specimens that were irrigated with EDTA/CHX displayed significantly the highest mean bond strength value ($p<0.001$). Specimens mainly showed a cohesive failure pattern, regardless of final irrigation regime.

Conclusion: Using 2% CHX in the final irrigation after 17% EDTA was improved AH Plus's bond-strength. Final irrigation with EDTA followed by CHX was more effective at improving bond strength of AH Plus compared to QMix that consists EDTA and CHX.

Key Words: adhesion, push-out bond strength, root canal irrigation, root canal sealer

ÖZET

Amaç: Son yıkamada kullanılan farklı kök kanal irrigasyon solüsyonlarının epoksi rezin esaslı kök kanal dolgu patının (AH Plus), kök kanal dentinine bağlanma dayanımı üzerindeki etkilerini incelemektir.

Materyal Metod: Kırk sekiz adet tek kanallı, alt çene, ön ve yan keser diş kullanılmıştır. Şekillendirme sırasında örnekler %2,5'luk sodyum hipoklorit ile irrige edilmiş, şekillendirme bitiminde son yıkama solüsyonuna göre örnekler rastgele 4 gruba ayrılmıştır (n = 12): Grup 1: 5 ml %17 etilendiamintetraasetik asit (EDTA); Grup 2: 5 ml %17 EDTA ardından 5 ml %2 klorheksidin glukonat (CHX), Grup 3: 5 ml QMix; ve Grup 4: kontrol grubu olarak 5 ml distile su. Tüm örnekler güta-perka ve AH Plus ile doldurulmuştur. Bağlanma dayanımı testi için her örnekten 1 mm kalınlığında dörder kesit elde edilmiştir. Bağlanma dayanımı verileri tek yönlü Anova ve Bonferroni testleri ile analiz edilmiştir ($p <0,05$).

Bulgular: EDTA/CHX ile irrige edilen örneklerde bağlanma dayanımı değerleri istatistiksel olarak daha yüksek bulunmuştur ($p<0,001$). Son yıkama solüsyonlarından bağımsız olarak örneklerin çoğunda koheziv başarısızlık gözlenmiştir.

Sonuçlar: Son yıkamada %17 EDTA'yı takiben %2 CHX kullanımı AH Plus'ın bağlanma dayanımı değerlerini arttırmıştır. Son yıkamada EDTA ve CHX ayrı ayrı uygulamak AH Plus'ın bağlanma dayanımını, içeriğinde EDTA ve CHX barındıran QMix'e göre daha olumlu etkilemiştir.

Anahtar Kelimeler: adezyon, itme-bağlanma dayanımı, kök kanal irrigasyonu, kök kanal patı

* Hacettepe University Faculty of Dentistry Department of Endodontics
** Bülent Ecevit University Faculty of Dentistry Department of Endodontics
*** Hacettepe University Faculty of Medicine Department of Biostatistics

INTRODUCTION

The use of gutta-percha with a root canal sealer is considered as standard procedure in root canal filling.[1,2] Root canal sealer should present adequate flow for filling gaps between gutta-percha cones and the canal walls and bond strength to root dentin for contributing to the obturation of the root canal system, because gutta-percha has no adhesion to the canal walls.[1-4] Different types of sealers have been introduced to the dental market constantly to develop new products having better adhesive properties than the commonly used sealers.[3, 5]

Certain important factors may interfere with the sealer adhesion, such as the root canal preparation and cleaning, the filling technique, and the type of sealer.[6] There are many studies regarding the effect of different final irrigation regimens on the bond strength of sealers. According to the results of the studies, authors claim that final irrigating protocols impact the adhesion of sealers to root dentin.[7-10]

AH Plus (Dentsply, Konstantz, Germany) is one of the commonly used epoxy-resin-based sealer, which has excellent sealing properties and considered as a gold standard against which all new sealers must be compared.[2, 4]

This study was designed to examine the effect of final irrigant regimens (17% EDTA, 17% EDTA/2% CHX, QMix, Distilled water as control) on the push-out bond strength of AH Plus to root dentine. The null hypothesis tested was these regimens had no influence on the sealer–dentine bond strength of AH Plus.

MATERIALS AND METHODS

Forty-eight extracted human mandibular incisors were radiographed to select only those with single root, single canal and a similar radicular morphology. Teeth with caries, cracks and immature apices were excluded. The selected teeth were decoronated 12 mm from the anatomic apex. Working length was established using a size 10 K-file (Mani Inc, Tochigi, Japan) to the root canal terminus and subtracting 0.5 mm from this measurement. The root canals were prepared using ProTaper rotary instruments (Dentsply Maillefer, Ballaigues, Stwizerland) up to F3. Warm wax (Modelling Wax; Dentsply DeTrey, Weybridge, UK) was used to seal the apical foramen. After each instrument, 3 mL of 2.5% sodium hypochlorite (NaOCl) was used for irrigation. After instrumentation was completed all specimens were irrigated with 5mL of 2.5% NaOCl. After the instrumentation and drying of the root canals with absorbent paper points, the roots were assigned to four groups (n=12) according to the final rinse protocol: Group 1: 5 mL of 17% EDTA (Biodinâmica, Ibiporã, Brazil), maintained in the root canal for 1 min; Group 2: 5 mL of 17% EDTA, maintained in the root canal for 1 min and 5 mL of 2% chlorhexidine gluconate (CHX, Drogsan Medicine, Ankara, Turkey) maintained in the root canal for 1 min; Group 3: 5 mL QMix (Dentsply Tulsa Dental Specialties, Tulsa, OK, USA), maintained in the root canal for 1 min and Group 4: 5 mL distilled water (control group).

All the root canals were dried with paper points. Then the root canals were filled using AH Plus (Dentsply, Konstantz, Germany) sealer and a F3 gutta-percha point (Dentsply Maillefer, Ballaigues, Switzerland) using single cone technique. After canal obturation, roots were radiographed to make sure the canals were fully obturated. After root filling, the coronal 1 mm of the filling materials was removed from each specimen, and the space in each was filled with a temporary filling material (Cavit; 3M ESPE, Seefeld, Germany). Subsequently, all specimens were stored at 37 °C in 100% humidity for 2 weeks to allow the sealers to fully set and then the roots were embedded into acrylic resin blocks.

Before push-out testing, each root was horizontally sectioned into 1-mm-thick slices with a water-cooled precision saw (Isomet; Buehler, Lake Bluff, IL). Four slices were obtained from each root from the coronal-to-apical direction. Sections were eliminated from the study in the case of any voids in the root filling or if they had a non-circular shape. Three different-sized plungers (0.6, 0.7 and 0.8 mm) were used to closely match the size of the filling material. The plungers were connected to the load cell of a universal testing machine (Lloyd; Fareham, Hants, England). A vertical load was applied in an apical to coronal direction at a rate of 1.0 mm/min on the root canal filling. Failure was determined when the graph showed a reduction in load. The maximum failure load was recorded in Newtons and was used to calculate the push-out bond strength in megapascals (MPa)

according to the following formula[11]:

$$\text{Push-out bond strength (MPa)} = \frac{\text{Maximum load (N)}}{\text{Adhesion area of root canal filling (mm}^2\text{)}}$$

The adhesion area of each section was calculated as: $(\pi r_1 + \pi r_2)\, L$, where $L=\sqrt{(r_1-r_2)^2+h^2}$, π is the constant 3.14, r_1 is the smaller radius, r_2 is the larger radius, and h is the thickness of the slice in mm.

The data were analyzed using one-way ANOVA and the post hoc Bonferroni test. Statistically significant differences among the groups were set at $p < 0.05$. After the push-out bond strength test, the failure modes were analyzed by examining each debonded specimen under a stereomicroscope (Olympus Corporation, Taichung, Taiwan) at 40x magnification. The failures were classified according to Huffman *et al.*[12]: adhesive failure: along the sealer-dentine interface; cohesive: within the sealer; or mixed failures: that consisted of partial adhesive failure along the dentinal walls and partial cohesive failure within the sealer.

RESULTS

The mean values of bond strengths recorded for experimental groups and control group are presented in Table 1. There was a significant difference between groups ($p<0.05$). Specimens irrigated with EDTA/CHX (2.82 ± 0.52) displayed significantly higher bond strengths values compared to EDTA, QMix and distilled water ($p<0.001$, for all comparisons). The modes of fracture are displayed in Figure 1. Cohesive failure was the most frequent type of failure in all groups.

Table 1: The mean values of push out bond strength (MPa) and standard deviation of experimental groups.

Groups	Final irrigation regimen	Mean ± Std Dev.
1	EDTA	1.65 ± 1.16^a
2	EDTA/CHX	2.82 ± 0.52^b
3	QMix	1.34 ± 0.78^a
4	Distilled Water (control group	1.56 ± 0.82^a

*Different superscript letters indicate statistically significant differences between groups ($p < 0.05$).

DISCUSSION

In the present study EDTA/CHX combination favored the push out bond strength values of AH Plus sealer to root canal dentine as previously reported Hashem *et al.*[13] Lottani *et al.*[14] reported that the type of calcium chelating agent has a significant impact on the root dentine wall, EDTA will cause a complete demineralization of the exposed wall, whilst organic acids cause a mineral gradient. Previous studies reported higher bond strength values for AH Plus to dentin treated with chelates after NaOCl irrigation.[8,10,15,16]

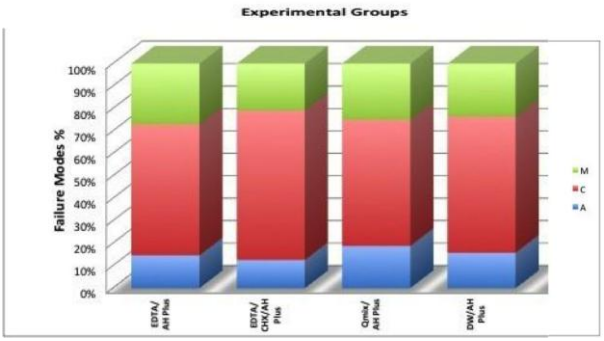

Figure 1: Failure pattern distribution of experimental groups tested (Adhesive failure (A): along the sealer-dentine inter face; Cohesive (C): within the sealer; or Mixed failures (M): that consisted of partial adhesive failure along the dentinal walls and partial cohesive failure within the sealer. DW: Distilled Water).

CHX has been suggested as an alternative irrigating solution that could replace NaOCl, especially in cases of open apex or allergy, because of its biocompatibility.[17,18] Furthermore, it has been speculated that CHX could have a positive effect on dentine bonding because of its inhibitory effect on matrix metalloproteinases.[19] Flushing the root canal with 2% CHX after 17% EDTA enhanced the bond strength due to the presence of surface surfactant in CHX composition that increases the dentine permeability as mentioned before.[9,13]

QMix is a new irrigating solution that contains EDTA, 2% CHX, and a detergent, and its pH is slightly above neutral. It removes smear layer as effectively as 17% EDTA[20] and favors the wetting of root canal dentine by AH Plus.[7] The presence of surfactants in

QMix did not increase the bond strength of AH Plus in relation to 17% EDTA consistent with previous study.[21] The rationale of adding a surface-active agent in QMix is because of its ability to lower surface tension of solutions and increase their wettability.[22] On the other hand, it is reported that the combination of surfactants does not alter the properties of EDTA-based formulations.[23] Ballal *et al.*[7] displayed that wettability or spreading of AH Plus on root canal dentine was reduced when only EDTA was used as the final irrigant compared to QMix and authors attributed this result to the presence of surface surfactant in CHX composition, which increases the dentin surface energy and, hence, its wettability, a property that is required for the adhesion of sealer. Also in the present study, mean bond strength values of specimens irrigated with EDTA/CHX were significantly higher than EDTA alone. However, there was no difference between EDTA alone and QMix regarding the bond strengths, so the higher bond strength values could not be attributed to only CHX existence.

The materials tested were prepared and applied according to the manufacturer's instructions, in the current study. Thus, AH Plus was used with gutta-percha cones. However, when testing the push-out bond strength, failure could occur at the gutta-percha/sealer interface. Clinically, however, filling with mere AH Plus is not advisable, because the material sets to a hard consistency and thus makes retreatment almost impossible.[15] There is a correlation between the failure modes and bond strength of the AH Plus. The amount of cohesive failures could explain the highest adhesion to dentine. This is in agreement with the findings of Prado *et al.*[9] who reported a cohesive failure pattern in the AH Plus sealer group.

CONCLUSION

Within the limitation of this study, the null hypothesis was rejected. EDTA/CHX combination improved AH Plus bond strength to dentine compared to EDTA alone and QMix.

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Yazışma Adresi:
Emel Uzunoglu, DDS, PhD
Department of Endodontics,
Faculty of Dentistry, Hacettepe University
Sıhhiye, Ankara/Turkey, 06100.
Phone: +903123052260
Fax: +903123104440
E-mail address: emel_dt@hotmail.com