16.05.2018: Müracaat Tarihi / Application Date
02.07.2018: Kabul Tarihi / Acceptance Date

Effect of Dual Rinse® HEDP Root Canal Irrigation Solution On Coronal Dentin Adhesion

Dual Rinse® HEDP Kök Kanalı Yıkama Solüsyonunun Koronal Dentin Adezyonuna Etkisi

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Öz

Amaç: Bu çalışmanın amacı, Dual Rinse® HEDP kök kanal yıkama solüsyonunun kompozitlerin koronal dentine adezyonuna etkisinin incelenmesidir. **Gereç ve Yöntem:** 40 adet çürüksüz 20 yaş diş seçilerek, okluzal seviyelerinden 3mm kaldırılarak dentin tabakaları ortaya çıkarıldı. Bu düz yüzey parlatıldı ve rastgele olarak, kullanılan son yıkama solüsyonlarına göre 4 gruba (n=10) ayrıldı. Gruplar şu şekilde oluşturuldu: G1: 5% NaOCl+ distile su, G2: 5 % NaOCl+17%EDTA, G3: 5% NaOCl+ Dual Rinse HEDP, G4: 5% NaOCl+ %20 CA. Hazırlanan tüm yüzeylere Clear SE Bond ile muamele edildikten sonra Clearfill Posterior Kompozit rezin bloklar (her bir blok 2 mm yükseklikte ve 0.9 mm çaptadı) dişin vestibülüne ve lingualine 3mm aralık olacak şekilde yerleştirildi ve ışıkla polimerize edildi. Universal test makinesi kullanılarak 1.0 mm/dak hızında bağlantı gücü testi uygulandı ve çıkan sonuçlar Mega Pascal birimine çevrildi. Sonuçlar tek yönlü ANOVA ve Duncan testi ile istatistiksel olarak analiz edildi. Kırılma modları yüzde olarak incelendi. **Bulgu:** Grup 1 (12.04 ± 0.81 MPa), grup 2 (11.49 ± 1.36 MPa) ve grup 3 (12.25 ± 1.42 MPa) arasında istatistiksel olarak farklılık bulunmamıştır ($p > .05$). Test edilen gruplar arasında en düşük bağlantı gücü, grup 4 (12.25 ± 1.42 MPa) de bulunmuştur ve diğer gruplardan istatistiksel olarak anlamlı bir şekilde düşüktür ($p<.05$).**Sonuç:** Bu çalışmanın bulguları ışığında, Dual Rinse® HEDP kök kanal yıkama solüsyonunun koronal dentin adezyonu üzerinde herhangi olumsuz bir etkisi görülmemiştir ve günümüzde NaOCl ile birlikte en sık kullanılan şelasyon ajanı olan EDTA solüsyonuna bir alternatif olarak önerilebilir.

Anahtar Kelimeler : Endodonti, EDTA, HEDP, Sitrik Asit

Abstract

Objective: The aim of this study was to examine the effects of Dual Rinse HEDP solution on coronal dentin adhesion. **Material and Method:** 40 teeth were sectioned approximately 3 mm below the occlusal level, and flat bonding surfaces will be polished and then randomly divided into 4 groups (n = 10) according to the final irrigant used G1: 5% NaOCl+ distilled water, G2: 5 % NaOCl+17%EDTA, G3: 5% NaOCl+ Dual Rinse HEDP, G4: 5% NaOCl+ %20 CA. All prepared surfaces were treated with Clear SE Bond. Clearfill Posterior Composite Resin blocks was placed on the vestibul and on the palatinal of the bonded area then light cured. The bond strength was tested with an universal test machine at a crosshead speed of 1.0 mm/min and calculated in mega pascals. Data was analyzed using a one-way ANOVA and Duncan's tests. Failure modes were analyzed given as percentage. **Results:** There was no statistically significant difference between group 1 (12.04 ± 0.81 MPa), group 2 (11.49 ± 1.36 MPa), group 3 (12.25 ± 1.42 MPa). Among the tested groups, group 4 (7.40 ± 0.76) which has the lowest bond strength values showed significant differences only all other groups ($p<.05$). **Conclusion:** Based on the findings of this study, it can be concluded that Dual Rinse HEDP solution does not jeopardize coronal dentin adhesion and may be recommended as an alternative to the most commonly used EDTA solution in combine used with NaOCl.

Keywords: Endodontics, EDTA, HEDP, Citric Acid,

Introduction

The success of endodontic treatment depends on optimal chemomechanical root canal clearance, ideal irrigation, and the three-dimensional filling of the root canals. However, even when all of these conditions are met, failures in coronal restorations affect the success of the treatment in a negative way (1–3). Because of the importance of coronal restorations, they should be done both ideally and urgently (4–6).

Dentin adhesion depends on many factors, such as the status of peritubular and intertubular dentin, dehydration, and the presence of Ca^{++} ions on the surface. Unfortunately, the solutions used in root canal treatment can negatively affect the chemical and mineral structure of the coronal dentin. The most commonly used irrigation solution in root canal treatment is sodium hypochlorite (NaOCl), and the effects of NaOCl on the root and coronal dentin have been investigated by many researchers (7). NaOCl irrigation alone in root canal treatment is not enough to achieve the desired results. Chelation agents are needed to remove the smear layer, but these agents tend to have certain effects on the dentin (8,9). Ethylenediaminetetraacetic acid (EDTA) is the most commonly used chelating agent in root canal treatment, and it removes the smear layer, which is one of the most important stages. Nowadays, instead of EDTA, different chelating agents and organic acids are being used to remove the smear layer. Citric acid (CA) is a mild etching material that serves as an effective irrigation solution for eliminating the smear layer, depending on the dissolution of the inorganic phase of the dental tissues (10). CA can cause an enlargement of the dentine tubule openings and expose the collagen matrix (11). A newly suggested chelating agent, 1-hydroxyethylidene 1,1-bisphosphonate (HEDP), has been recommended as a chelating agent in root canal treatment because of its biocompatibility and combined availability with NaOCl (12). The mixed application of HEDP and NaOCl can effectively remove the smear layer, and it has a minimal effect on the root dentin wall (13); however, HEDP does not affect the proteolytic and antimicrobial properties of the NaOCl (12). A new material, Dual Rinse HEDP (Medcem GmbH, Weinfelden, Switzerland), has been suggested for the continuous irrigation of the root canals. However, there is a lack of knowledge about Dual Rinse HEDP in the literature.

It is important to choose the right technical procedure to protect the root canal system from contamination in order to achieve long term, successful endodontic treatment, in addition to the quality of the root canal treatment, the coronal microleakage is the most important factor that the influence the quality of the complete tooth treatment. The aim of this study was to examine the effects of the different chelating agents used during root canal treatment on the coronal dentin adhesion.

Material and Methods

This in vitro study was approved by the Pamukkale University Ethics Committee (16.05.2017- Process no: 7). For this research, 40 sound human third molars were stored for up to 4 months in a 0.2% thymol solution at 4°C prior to use. To obtain the each coronal dentin surface, approximately 3-mm occlusal thickness was cut with a low-speed diamond saw (Micracut; Metkon, Bursa, Turkey). Two-part autopolymerizing polymethyl methacrylate resin (Imicryl, Konya, Turkey) was mixed and poured into the plastic mold, surrounding each of the specimen completely and set to cure. Flat dentin surfaces were created by a polishing machine (Metkon Forcipol 300-1V, Bursa, Turkey) with 200 to 1,000 grit sandpaper under running water. and each sandpaper was used for 1 minute. All specimens were irrigated with 5% NaOCl for 10 minutes. Then, the specimens were randomly assigned into 4 groups (n=10) based on the final irrigant used (Table 1):

After the preparations completed, all specimens were ultrasonically cleaned (EasyClean Ultrasonic Cleaner; RenfertGmbh & Co., Hilzingen, Germany) for 2 minutes and air dried. Then, Clearfil SE Bond (Kuraray, Osaka, Japan) was applied to all prepared surfaces according to the manufacturer's instructions (Table 2).

By the aid of a silicone tube, very tiny cylinders of resin composites (Clearfil Posterior Composite Resin, Kuraray, Osaka, Japan), approximately 0.9 mm in diameter and 2 mm in height, were bonded to the vestibul and lingual of each dentin surface as it will be 3 mm interspace and polymerized for 20 seconds with a LED light curing device (Elipar S10 LED Curing Light, 1200 mW/cm2; 3M ESPE).

The specimens were stored in distilled water at 37°C for 1 week until the microshear bond test was completed. Another 4 representative specimens were prepared and additionaly examined by scanning electron microscope (SEM) (Figure 1).

Table 1 Randomly distribution of the groups according to final irrigation solutions

Groups (n=10)	Irrigation Solution	Time	pH	Manufacturer
1	distilled water	5 min.	12.5	
2	17% EDTA	5 min.	6-8	Meta Biomed, London, UK
3	DualRinse® HEDP	5 min.	11.5	MEDCEM, Switzerland
4	CA	5 min.	1.7	Dentsply, Tulsa, USA

Table 2 Materials used for this study

Product	Classification		Content	Manufacturer
Clearfil Majesty Posterior Composite	Nano-superfilled composite resin	*Organic matrix*	Bis- GMA, TEGDMA, hydrophobic aromatic dimethacrylate	Kuraray, Osaka, Japan
		Fillers	Silanated glass ceramic filler, surface-treated alumina microfiller	
Clearfil SE Bond	Two step self etchadhesive system	*Primer*	MDP, HEMA, water, multifunctional methacrylate, photoinitiator	Kuraray, Osaka, Japan
		Bond	MDP, HEMA, multifunctional methacrylate,microfiller, photoinitiator	

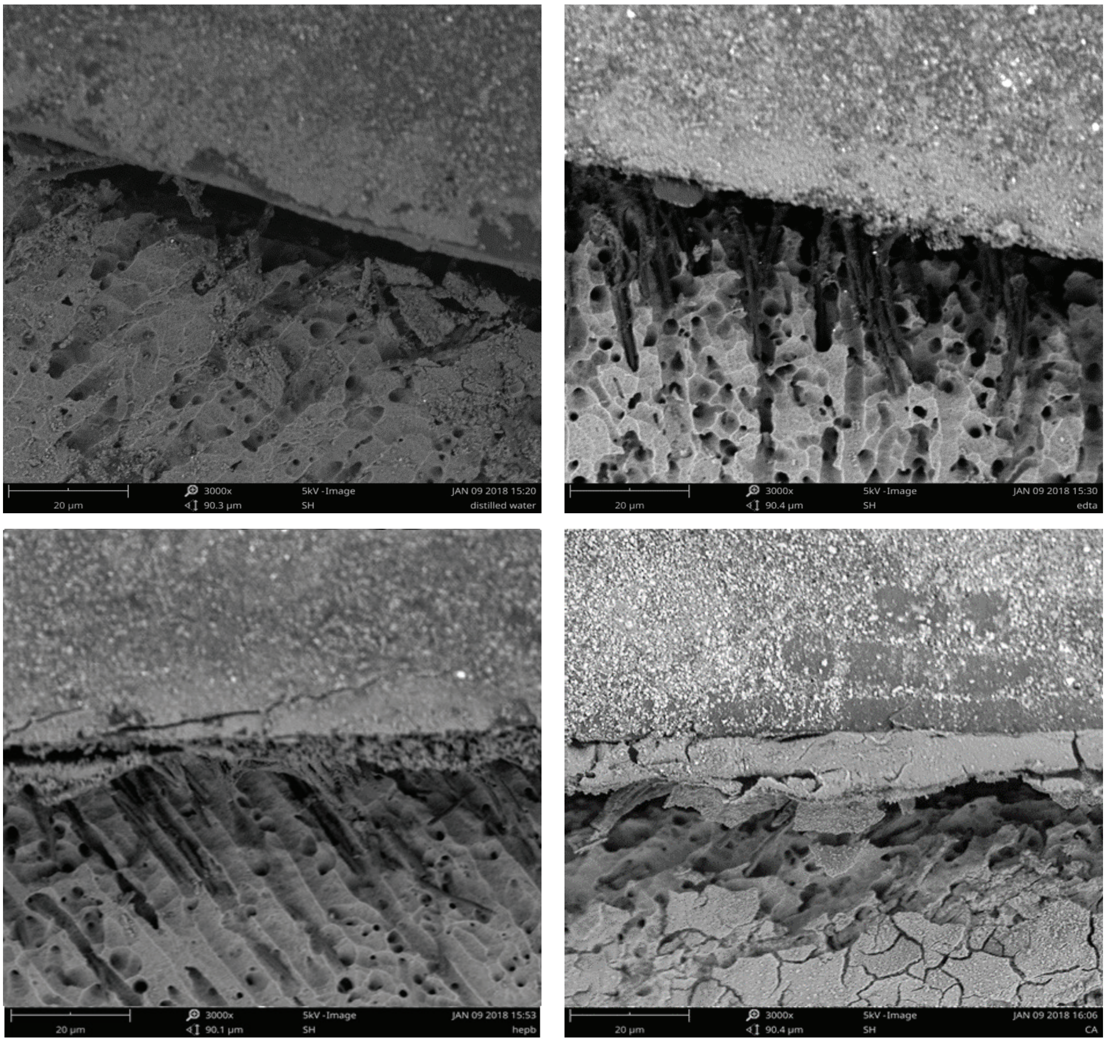

Figure 1. Representative SEM photos of hybrid layers.
A: Group 1 distilled water. B: Group 2 EDTA. C: Group 3 Dual Rinse HEDP. D: Group 4 Citric Acid

Microshear Bond Strength And Failure Analyses

The bond strength was tested with a universal testing machine (Devotrans Inc., Istanbul, Turkey) at a crosshead speed of 1.0 mm/min. The maximum loads at bond failure were recorded in Newtons (N), and the bond strengths were then calculated in megapascals (MPa) by dividing this value by the bonded area (mm2). The de-bonded area was examined with a stereomicroscope (SMZ 1500; Nikon, Tokyo, Japan) at 40x magnification for the failure mode analysis, which was classified as adhesive, cohesive, or mixed.

Statistical Analysis

A one way analysis of variance (ANOVA) was used to compare the group means with Duncan's post hoc test. To check the variance analysis assumption, the Shapiro-Wilk's test for normality and Levene's test for the homogeneity of variance were used. Descriptive statistics with confidence intervals for the mean were obtained to describe the basic features of the data. All the statistical analyses were performed using SAS 9.4 software (SAS Institute Inc., SAS Campus Drive, Cary, North Carolina 27513, USA).

Results

The data were normally distributed according to the Shapiro-Wilk's test results, and the Levene's test indicated the homogeneity of the variances ($p>0.05$). The differences between the group means were found to be statistically significant using the one way ANOVA ($p<0.01$). Table 3 summarizes the means and standart errors of the microshear bond strength of all groups. Group 1 (12.04±0.81 MPa), Group 2 (11.49±1.36 MPa), and Group 3 (12.25±1.42 MPa) were all at the same statistical significance level, whereas Group 4 was different from the others. Among all the groups, the highest values were found in Group 3 (12.25±1.42 MPa) and the lowest bond strength values were found in Group 4 (7.40±0.76 MPa). The difference was statistically significant ($p<0.05$).

The results of the failure modes are summarized in Table 4 as percentages. In all groups, adhesive failures occurred most often. The groups with the highest bond strength values exhibited more cohesive failures than the other groups.

Discussion

For this research, the null hypothesis was that the effects of using Dual Rinse® HEDP as a final irrigant would not differ from the other tested chelating agents regarding the coronal dentin bond strength. The null hypothesis of this study was partly rejected, because the CA group exhibited lower dentin bond strengths than the other groups. In adhesive dentistry, the dental material's bond strength can be tested using several methods (14). Due to the critical size of the bonding defects that can occur during the preparation of the samples, macro-bonding tests have developed into micro- bonding tests that are more powerful (15). In the present study, the micro-shear bond test was chosen to evaluate the bond strength of the coronal dentin altered by the chelation agent.

According to Perez-Heredia, the decalcifying capacities of the EDTA and CA are highest during the first 5 minutes (16). Because of this, in the present study, the chosen irrigation time for the chelation agents was 5 minutes on the coronal dentin.

Table 3 Descriptive statistics and one way anova results

		Descriptive Statistics				Confidence Limits for Mean		One- Way ANOVA	
Groups	n	Mean	Std Dev	Min.	Max.	Lower 95%	Upper 95%	F	p value
DSTL	20	12.05^{A}	3.64	7.39	20.13	10.35	13.75	4.07	0.0097
EDTA	20	11.49^{A}	6.10	4.25	23.98	8.64	14.35		
HEDP	20	12.26^{A}	6.35	5.50	30.75	9.28	15.23		
CA	20	7.41^{w}	3.43	3.30	15.57	5.80	9.01		
Total	80	10.80	5.35	3.30	30.75	9.61	11.99		

Table 4 Percentage of failure modes of specimens (%)

Experimental groups	n	Adhesive %	Cohesive %	Mix %
1 DSTL	20	60	40	-
2 EDTA	20	60	10	30
3 HEDP	20	50	40	10
4 CA	20	70	-	30

SE Bond was chosen as the bonding agent in this study because it contains weak acids. Weak acids alter the dentin less than the acids in total etch systems. In total etch systems, after administering the strong acids, air drying must be used carefully to prevent the dentin from collagen collapse. The shear bond strength can diminish because of this collapse (17).

The adhesion of adhesive systems on dentin is a challenge after root canal treatment because of the use of the different root canal treatment chemicals. For example, NaOCl is the most commonly used irrigant for the disinfection of root canals (14), and it can affect the coronal dentin. The remnant superoxide radicals from the NaOCl on the dentin surface can inhibit the polymerization of the resin monomers (18–21). In all the groups, NaOCl was used to mimic the final irrigation of the root canal treatment.

The use of EDTA is an important step in the removal of the smear layer from the root dentin, and clinically, EDTA is the chelation agent used most often for this purpose. While EDTA demineralizes the peritubular dentin, the intertubular dentin is less affected. This allows the resin monomers to undergo better infiltration, and the unaffected areas become more resistant to dehydration (22,23). This may explain why the results of the EDTA use in the microshear test were not different from the results of the distilled water, according to our results. Moreover, EDTA can remove more Ca++ ions than HEDP (24). The presence of Ca++ ions is important in the adhesion of the dental adhesive to the dentin (25). Because of this, we concluded that the EDTA bond strength was less than that in the HEDP and control groups, but it was not statistically significant. Unfortunately, there are no studies in the literature examining HEDP irrigation on coronal dentin. HEDP is a chelating agent that can be mixed with NaOCl. Although we used it without mixing to avoid exposing the samples to NaOCl in excess of the other agents, the ability to use the two agents together in the clinic will save time while disinfecting the root surfaces and removing the smear layer during the chemo-mechanical cleaning of the root canals. As seen in our study, there will be no difference in the coronal dentin adhesion.

According to Gonzalez-Lopez, there were no significant differences in the amount of Ca++ extracted by the 10% or 20% citric acid or by the 17% EDTA in bovine teeth (26). However, the demineralization and drying caused a shrinkage in the dentin structure (27). The demineralization agents preferentially attack the peritubular dentin more than the intertubular dentin (28), but the acidic conditioning can cause a collapse of the intertubular zone and demineralization of the peritubular zone more quickly (29). In addition, demineralized dentin is more sensitive to drying, and because of this, wet bonding systems have been developed (30,31). Nakabayashi and Takarada concluded that etching with 10% citric acid followed by drying induced the collapse of the collagen and resulted in poor quality bonded layers (32). In our study, we used 20% citric acid at a pH of 1.7, while the pH of the other agents was basic, and the lowest bond strength results were in the CA group.

According to Kahveci and Belli (33) higher bond strength values produce more cohesive failures than adhesive failures. In this study as well, the Dual Rinse HEDP group and the distilled water group had the highest bond strengths and produced more cohesive failures than the citric acid group.

Conclusion

In light of this study, it can be said that only the chelating agents used at an acidic pH reduced the coronal dentin bond strength, while the agents used at a basic pH did not affect this bonding. However, the adhesion effects of these agents on the coronal dentin should be investigated using different adhesive systems. Based on the findings of this study, it can be concluded that the Dual Rinse HEDP solution did not jeopardize the coronal dentin adhesion, and it can be recommended as an alternative to the commonly used EDTA solution in combination with NaOCl.

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