

Effect of NaOCl and EDTA as Post Space Cleansing Solutions on the Bond Strength of Resin Cements to Root Canal Dentin (An in vitro Study)

Raghad A Al-Askary
BDS, MSc (Lec.)

Department of Conservative Dentistry
College of Dentistry, University of Mosul

الخلاصة

الأهداف: لتقييم القوى الرابطة الموضعية لأربعة مواد لاصقة اسمنتية راتنجية لعلاج موضع القلب اللي بعد غسله بعدة أنظمة لمحاليل الارواء. **المواد وطرائق العمل:** تم استخدام ثمانون ضاحك سفلي بشري مقلوع، بعد أن تم بتر تيجان الأسنان وتحضير اقنيته اللبية وحشوها، تم تحضير موضع القلب اللي لكل جذر، ثم تم تقسيمها وبشكل عشوائي إلى أربع مجموعات (٢٠ جذر للمجموعة الواحدة) طبقاً لنظام محلول الارواء المستخدم للقلب اللي وكالاتي: مجموعة (١) ماء مقطر (مجموعة شاهدة)، مجموعة (٢) ٥.٢٥% محلول هايوكولورايت الصوديوم+ماء مقطر، مجموعة (٣) ١٧% EDTA+ماء مقطر، مجموعة (٤) ٥.٢٥% محلول هايوكولورايت الصوديوم+١٧% EDTA+ماء مقطر. ثم تم تقسيم كل مجموعة إلى أربع مجاميع فرعية (n=5) طبقاً للمواد اللاصقة الاسمنتية وكالاتي: المجموعة (٤،٣،٢،١) أي: (Vivaglass®Liner)، المجموعة (٤،٣،٢،١) بي: (PermaCem®-Dual)، المجموعة (٤،٣،٢،١) سي: (Variolink II)، المجموعة (٤،٣،٢،١) دي: (LuxaCore®Z-Dual). ثم قطع كل موضع قلب لي إلى ثلاث شرائح افقية. تم استخدام اختبار الدفع للخارج لقياس القوى الرابطة الموضعية، وقد تم تحديد أنماط الفشل باستعمال المجهر الجسم. **النتائج:** ان استخدام ٥.٢٥% محلول هايوكولورايت الصوديوم+١٧% EDTA+ماء مقطر أعطى أعلى قياس للقوة الرابطة من بقية المعالجات الأخرى بينما المجموعة الشاهدة أعطت اقل النتائج. بالنسبة لـ (LuxaCore®Z-Dual) سجل أعلى قوة ربط. اما (Vivaglass®Liner) سجل اقل قوة ربط. أما قوة الربط الموضعية فإنها تقل بالاتجاه الذروي للجذر. بالنسبة لنمط الفشل المسجل فكان على الأغلب من النمط اللاصقي ماعدا في المجموعات (٣ دي، ٤ دي) فقد تم تسجيل فشل من النوع المركب في الجزء التاجي للجذر. **الاستنتاجات:** تبين في هذه الدراسة أن استعمال هايوكولورايت الصوديوم+١٧% EDTA له تأثير فعال على قوة الربط الراتنجية إلى عاج قناة الجذر. و أن (LuxaCore®Z-Dual) اظهر أعلى قوة ربط موضعية لعلاج قناة الجذر. وان قوة الربط الموضعية تقل من الاتجاه التاجي إلى الاتجاه الذروي للجذر.

ABSTRACT

Aims: To evaluate the regional bond strength of four resin-based luting cements to post space dentin after irrigating with different irrigant solutions regimens. **Materials and Methods:** Eighty extracted human lower premolars were decoronated, instrumented, and obturated. Post space was prepared in each root, then randomly divided into four groups (n=20) according to the final irrigation regimen for the post space, Gp.1: distilled water (DW) control; Gp.2: 5.25% NaOCl+DW; Gp.3: 17% EDTA+DW; Gp.4: 5.25% NaOCl+17% EDTA+DW. Each group was further subdivided into four subgroups (n=5) according to the luting cements, Gp.(1,2,3,4)A (Vivaglass®Liner); Gp.(1,2,3,4)B (PermaCem®-Dual); Gp.(1,2,3,4)C (Variolink II); Gp.(1,2,3,4) D (LuxaCore®Z-Dual), then each post-space was sectioned horizontally into three slices. A push-out test was performed to measure regional bond strengths and the fracture modes was evaluated using a stereomicroscope. **Results:** The use of 5.25% NaOCl+17% EDTA+DW result in higher bond strength than other treatments. While the control group gives the lowest. (LuxaCore®Z-Dual) showed the highest bond strength than other resin cements. (Vivaglass®Liner) gives the lowest bond strength. The regional bond strengths decreased significantly toward the apical third. The failure mode recorded was mostly adhesive in nature except for groups (3D,4D) showed some mixed failure at the coronal third. **Conclusions:** NaOCl+ EDTA flush had a profound effect on resin bond strength to radicular dentin. (LuxaCore®Z-Dual) composite core build-up material exhibited the higher regional bond strength to radicular dentin. The regional bond strength decreased from coronal to apical direction.

Key words: NaOCl, EDTA, Bond strength, root canal.

Al-Askary RA. Effect of NaOCl and EDTA as Post Space Cleansing Solutions on the Bond Strength of Resin Cements to Root Canal Dentin (An in vitro Study). *Al-Rafidain Dent J.* 2013; 13(2): 266-274.

Received: 6/2/2012

Sent to Referees: 12/2/2012

Accepted for Publication: 10/4/2012

INTRODUCTION

The creation of a strong and stable bond between luting cements and radicular dentin will contribute to the clinical performance of luted post.^(1,2)

Resin cements have been selected for their advantageous mechanical and adhe-

sive properties compared with conventional luting cements for post cementation.^(3,4,5)

In addition to the traditional smear layer produced by manually or rotary instrumentation of the root canal, the subsequent preparation of the post space using post drills resulted in an additional and

even thicker smear layer composed of debris and sealer/gutta-percha remnants that has adverse effect on the adhesion to the radicular dentin.⁽⁵⁻⁷⁾ Thus, achieving clean dentinal surfaces after mechanical post space preparation seems to be a critical step for optimal post retention particularly when resin cement is used.⁽⁸⁻¹¹⁾

Dentin surface treatment with different irrigation regimens may cause alteration in the chemical and structural composition of human dentin, thereby changing its permeability and solubility characteristics and hence affecting the adhesion of materials to dentin surface.^(1,2,5,7,12)

Sodium hypochlorite (NaOCl) and ethylenediaminetetraacetic acid (EDTA) are substances usually used during the endodontic treatments.^(6,10) NaOCl used for their antibacterial and tissue-dissolving properties for the organic portion of smear layer.^(4,9,13) EDTA is a chelating agent that removes calcium ions to produce dentin demineralization.^(8,9,12)

Adhesion to radicular dentin may be affected by many factors like the presence and thickness of endodontic smear layer, the difficulty of the curing light to reach many parts of root canal dentin, the gaining of direct vision to the root canal, moisture control and adhesive application, and the effect of different viscosity of the luting cements.^(1-4,7,14)

Self-adhesive cements introduced in 2002 as a new subgroup of resin cements, these materials designed with the purpose of overcoming some limits of both conventional and resin cements. Self-adhesive cements do not require any pretreatment of the tooth substrate.^(1-3,5)

Dual-cure cements were developed to conciliate the favorable characteristics of self-cured and light-cured cements by extended the working time, and capable of reaching a high degree of conversion in either the presence or absence of light.^(1,3)

Recently, dual-cured resin composite for core build-up have also been used to cement prefabricated posts, studies showed that it is a luting materials with improved mechanical properties better than dual-cured resin cements.^(14,15)

The purpose of this in vitro study was to evaluate the regional bond strength of four resin-based cements to post-space

dentin after irrigation with sodium hypochlorite and ethylenediaminetetraacetic acid.

MATERIALS AND METHODS

Eighty extracted human lower premolars of single root canal with no root caries, carious cervical cavities, pre-existing restorations, root canal treatment, calcified canals, crack lines, open apices, and resorptive defects and with a round canal selected for this study. All teeth scaled, polished, and stored in distilled water at 37°C in an incubator until use. The crown of each tooth was removed at the cemento-enamel junction using diamond wheel saw (KG Sorensen SP, Brazil) under water coolant to make all canals 14 mm in length. Then the root canals were accessed, and the canal lengths were measured by inserting a size # 15 k-file (MANI, INC. JAPAN) into each root canal until the tip of the file was visible at the apical foramen, the working length was established 1 mm short of the apex. All root canals were prepared at the predetermined working length with ProTaper (Ni-Ti) rotary instruments (Endo-Mate DT, NSK NAKANISHI, INC., JAPAN) to size F3 according to the manufacturer's recommendations. 2ml of 2.5% NaOCl (FAS a commercial household bleach, Iraq) used for irrigation between each file size. After the preparation procedure was complete, the root canals irrigated with 5 ml of 2.5% NaOCl, dried with paper points (Dentsply Maillefer, Switzerland), and obturated using size F3 single cone gutta-percha (Dentsply Maillefer, Switzerland). AH plus root canal sealer (Dentsply, Detrey, GmbH, Germany) was used which mixed and handled according to the manufacturer's instructions. Excess gutta-percha then removed with a heated instrument and cold vertical compaction performed with endodontic plugger. The canal orifices sealed with glass-ionomer cement (Voco, Cuxhaven, Germany). The roots were stored in distilled water in 100% humidity at 37°C for 72h.

Eight millimeters segment of gutta-percha would be removed from each root canal obturation to prepare the post space using heated-endodontic Pluggers size 30, 25, 20 (JoHn-Quayle, England) then Peeso reamers (Dentsply, swiss made, Bal-

laigres) size 1-3 coupled with slow speed hand piece (W&H, Strauts, Austria) leaving 5mm of gutta-percha to preserve the apical seal. Then a rubber stopper placed on the spreader to verify the depth of the instrument within the canal and ensure that 5mm of intact gutta-percha remained in the apical portion of the root canal. Radiographs were taken to check the presence of any residual gutta-percha and sealer in the root canal walls along the prepared post space and to check the remaining 5 mm gutta-percha using dental x-ray equipment (Trofy, France). After post-space preparations were completed, the roots were then randomly divided into four groups (n=20) according to the final irrigation regimen for the prepared post space. **Group1:** 5ml

distilled water (DW) as control group. **Group 2:** 5ml 5.25% NaOCl followed by 5ml DW. **Group 3:** 5ml 17% EDTA (Technical & General LTD. London) followed by 5ml DW. **Group 4^(6,10):** 5ml 5.25% NaOCl followed by 5ml 17% EDTA followed by 5ml DW. All irrigants were delivered into the post spaces using a 28-gauge end-exiting needle and a 5 ml syringe. The EDTA was left in place for 15 sec.⁽⁶⁾ then the post space was flushed with distilled water and dried using paper points (Dentsply Maillefer, Switzerland). Then each group was further subdivided into four subgroups (n=5) according to the different dual-cured resin-based luting materials used. The compositions of the tested materials described in (Table 1).

Table. 1: Composition of the materials used in the present study

Resin based cement and bonding agent	Composition
Vivaglass®Liner (Ivoclar, Vivadent/Liechtenstein dual-curing self-adhesive glass-ionomer resin cement	Powder: Aluminosilicate glass, Catalyst and pigments. Liquid: Polyacrylic acid , 2-Hydroxyethyl- methacrylate (HEMA), Dimethacrylate, Catalyst, Water
PermaCem®-Dual (DMG, Hamburg, Germany) Universal dual-cured compomer Automix cement	Ionomer glass in a Bis-GMA based matrix of dental resins, activator, catalyst, additives.
Variolink II (Ivoclar, Vivadent/Liechtenstein) Dual-cured resin cement	Past A: Bis-GMA, urethane dimethacrylate (UDMA), triethyleneglycol dimethacrylate (TEGDMA), inorganic filler, ytterbium trifluoride, initiator, stabilizer. Past B: Bis-GMA, UDMA, TEGDMA, inorganic filler, ytterbium trifluoride, benzoyl peroxide, stabilizer.
LuxaCore®Z-Dual (DMG, Hamburg, Germany) dual-cured Zirconia-reinforced composite resin	Barium glass, pyrogenic silicic acid, nano fillers, zirconium oxide in a Bis-GMA-based dental resin matrix
Excite (Ivoclar, Vivadent, Liechtenstein), dual-cured adhesive	2-Hydroxyethyl- methacrylate (HEMA), dimethacrylates, phosphoric acid acrylate, silicon dioxide, and initiators and stabilizers in an ethanol solution

The application of each luting material was done according to the manufacturer's instructions. Prior to the application of luting materials, the external surfaces of the roots were built-up with resin composite to prevent light passing through the thin dentin walls to the bonding agent during photocuring. **Group(1,2,3,4)A:** Filled the post space with Vivaglass®Liner (Ivoclar, Vivadent/Liechtenstein). The standard powder/liquid ratio of 1.4 g/1.0 g can be achieved with a level Vivaglass measuring spoon of powder and one drop of liquid. Dispense the required amount of powder and liquid onto the mixing pad. Divide the powder into two equal parts; mix the first half with the liquid for 5-10s.

add the second half of the powder and mix for another 10-15s. total mixing time should not exceed 20s. apply the cement into the post space with a suitable applicator, light-cured for 60s. **Group(1,2,3,4)B:** Filled the post space with PermaCem®-Dual (DMG,Hamburg, Germany). Applied two coats of Excite bonding (Ivoclar, Vivadent, Liechtenstein) in to post space for 10s. with a brush of compatible size, removed excess adhesive with paper points, gently air dry, light cured for 20s. apply the automixed paste with the aid of root canal tip, remove excess cement with spatula, light cure for 60s. **Group(1,2,3,4)C:** Filled the post space with Variolink II (Vivadent, Amherst,

NY). Applied the Excite bonding as describe for (group B), dispense the required amount of past A&B onto the mixing pad, apply the mixed cement into the post space with a suitable applicator, remove excess cement with spatula, light-cured for 60s. **Group(1,2,3,4)D:** Filled the post space with LuxaCore®Z-Dual (DMG, Hamgurg, Germany). Applied the Excite bonding as describe for (group B), apply the automixed paste with the aid of root canal tip, remove excess cement with spatula, light cure for 60s. (we don't use acid etching with phosphoric acid in this study to obtain the pure effect of each irrigant solution on radicular dentin). Rather than use a post, post space filled with the resin cements to permit evaluation of cement-dentin bond strengths without the complications of bond to post versus bond to dentin⁽⁴⁾. Light curing probe was placed at a right angle to the coronal portion of the root for 60s using light curing unit (Astralix, Vivadent, Liechtenstein, Germany). Then 2mm composite core (Tetric, Vivadent, Liechtenstein, Germany) build up was performed on each root to avoid the risk of coronal leakage.

Each post space was sectioned horizontally into three slices 2 mm in thickness (Figure 1) representing the coronal, middle, and apical thirds of post space using diamond wheel saw (KG Sorensen SP, Brazil) under water coolant.

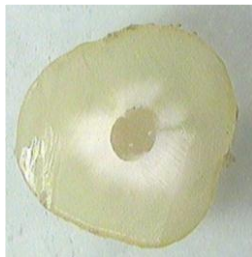


Figure (1): the prepared sample

The exact thickness of each slice measured using digital vernia (Metr-iso-geu.China). The sectioned specimens mounted on a custom-made jig and the cement was loaded with a 1mm diameter cylindrical plunger. The plunger tip sized and positioned to touch only the cement without stressing the surrounding root canal walls (Figure 2:a). The load was applied on the apical aspect of the sectioned

specimens in an apical-coronal direction to push the cement towards the larger part of the root slice. Loading performed using a computer controlled universal testing machine (TERCO, MT, Sweden) (Figure 2:b) at a crosshead speed of 1.0 mm/min until bond failure occurred.

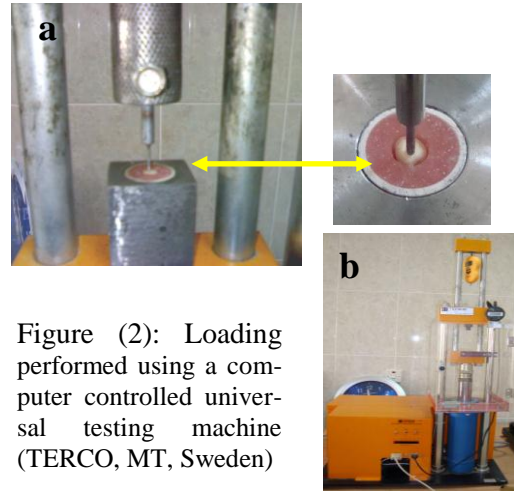


Figure (2): Loading performed using a computer controlled universal testing machine (TERCO, MT, Sweden)

The maximum failure load was recorded in newton and used to calculate the push-out bond strength in megapascals (MPa) according to the following formula⁽³⁾: $(\sigma = F_{max}/A)$, where (Fmax) was the maximum load when dislodgement of the luting cement was occurred, (A) the effective adhesive surface area which can be calculated according to the following formula:⁽³⁾ $A = \pi(r_1 + r_2)\sqrt{(r_1 - r_2)^2 + h^2}$. Where π =constant 3.14, (r_1 = larger radius, r_2 = smaller radius) the both were measured using the digital vernia, h=the thickness of the section in mm. Statistical analyses were performed using a two-way analysis of variance (ANOVA) and Duncan's multiple range test to determine if there were statistically significant differences among groups at ($p=0.05$). All failed specimens were examined in a stereomicroscope (Motic, TAIWAN) at X 20 magnification to classify the modes of failure. Failures were classified as adhesive (at cement/dentin interface), cohesive (within the cement or dentin), or mixed.^(2,4)

RESULTS

Two-way ANOVA (Table 2) showed that there were statistically significant differences ($p<0.05$) among the subgroups for the factors of final irrigation regimens,

resin cements and their interactions at different post space regions.

Table (2): Two-way analysis of variance for the factors of irrigation, resin cements and their interactions at three post space regions

	Source	DF	Type III Sum of Squares	Mean Square	F	Sig.
Coronal Third	Irrigation	3	380.839	129.946	410.071	.000
	Cement	3	352.853	117.618	379.937	.000
	Irrigation×Cement	9	30.396	3.377	10.910	.000
	Error	64	19.813	.310		
	Corrected Total	79	783.901			
Middle Third	Irrigation	3	234.701	78.234	85.914	.000
	Cement	3	238.145	79.382	87.175	.000
	Irrigation×Cement	9	32.731	3.637	3.994	.000
	Error	64	58.279	.911		
	Corrected Total	79	563.856			
Apical Third	Irrigation	3	85.618	28.539	61.413	.000
	Cement	3	15.391	5.130	11.039	.000
	Irrigation×Cement	9	12.428	1.381	2.972	.000
	Error	64	29.742	.465		
	Corrected Total	79	143.179			
DF: Degree of freedom		F: Calculated F. value		Sig: significant		

The mean push out bond strength values in MPa at three post space regions with Duncan's multiple rang test shown in (Table 3) and represented in Figures (3-5).

Table (3): The mean and standard deviation of push out bond strengths in MPa of groups at three post space thirds with Duncan's multiple rang test

Groups	N	Coronal	Middle	Apical
Gp.1A (DW+VG) control	5	10.07±0.43 ^g	6.74±0.57 ^c	4.78±0.52 ^e
Gp.1B (DW+PC) control	5	13.13±0.41 ^{def}	7.41±1.16 ^{de}	5.65±0.23 ^{cde}
Gp.1C (DW+VL) control	5	12.06±1.00 ^{efg}	6.86±0.62 ^e	5.15±0.61 ^{de}
Gp.1D (DW+LC) control	5	14.22±0.62 ^{cd}	10.27±0.49 ^b	5.35±0.63 ^{cde}
Gp.2A (NaOCl+DW+VG)	5	10.33±0.32 ^g	7.61±0.90 ^{de}	5.25±0.19 ^{cde}
Gp.2B (NaOCl+DW+PC)	5	13.07±0.45 ^{def}	10.03±0.51 ^{bc}	5.54±0.32 ^{cde}
Gp.2C (NaOCl+DW+VL)	5	11.79±1.05 ^{fg}	8.03±0.52 ^{cde}	5.49±0.30 ^{cde}
Gp.2D (NaOCl+DW+LC)	5	14.25±0.28 ^{cd}	10.48±0.33 ^b	5.20±0.60 ^{cde}
Gp.3A (EDTA+DW+VG)	5	11.19±0.22 ^{fg}	8.96±0.47 ^{bcd}	6.14±0.52 ^{bcd}
Gp.3B (EDTA+DW+PC)	5	16.06±0.26 ^{bc}	13.02±0.77 ^a	7.07±0.67 ^{abcd}
Gp.3C (EDTA+DW+VL)	5	13.79±0.87 ^{de}	9.74±0.64 ^{bc}	6.27±0.37 ^{bcd}
Gp.3D (EDTA+DW+LC)	5	19.19±0.53 ^a	13.84±0.53 ^a	7.12±1.13 ^{abc}
Gp.4A (NaOCl+EDTA+DW+VG)	5	14.51±0.27 ^{cd}	10.08±0.51 ^{bc}	6.76±0.67 ^{bcd}
Gp.4B (NaOCl+EDTA+DW+PC)	5	19.08±0.34 ^a	13.90±0.61 ^a	7.97±0.51 ^{ab}
Gp.4C (NaOCl+EDTA+DW+VL)	5	16.63±0.89 ^b	10.76±0.54 ^b	6.73±0.83 ^{bcd}
Gp.4D (NaOCl+EDTA+DW+LC)	5	20.35±0.42 ^a	14.69±0.40 ^a	8.75±0.59 ^a
Total	80	14.36±3.12 ¹	10.15±2.57 ²	6.20±1.21 ³

DW= distilled water, NaOCl= sodium hypochlorite, EDTA= ethelyndiamintetraacetic acid, VG=Vivaglass, PC= PermaCem®-Dual, VL=Variolink II, LC=Luxacore®Z Dual, Different letters indicated significant differences in each column at (p=0.05) , Different numbers indicated significant differences in the row at p=(0.05).

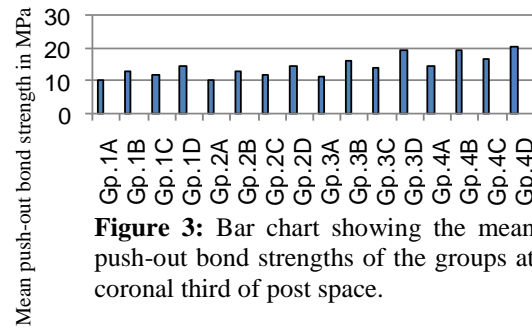


Figure 3: Bar chart showing the mean push-out bond strengths of the groups at coronal third of post space.

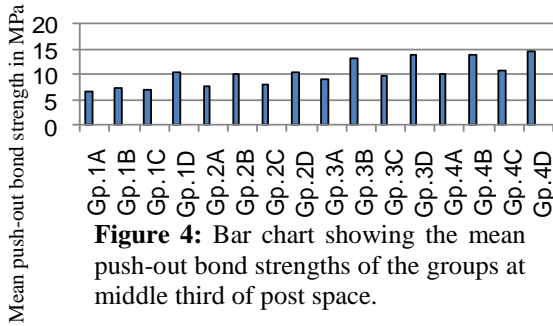


Figure 4: Bar chart showing the mean push-out bond strengths of the groups at middle third of post space.

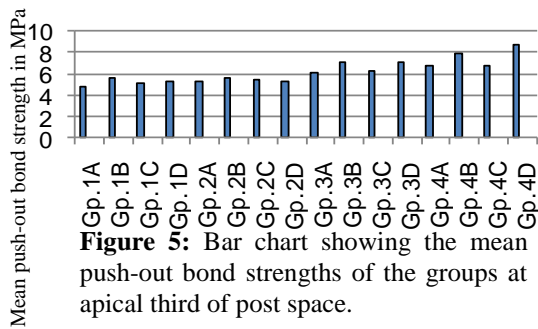


Figure 5: Bar chart showing the mean push-out bond strengths of the groups at apical third of post space.

In the coronal thirds Duncan's multiple rang test revealed that (3D,4B,4D) subgroups yielded significantly the highest mean bond strengths. While the significantly lowest means were recorded for subgroups (1A,2A). In the middle third the subgroups (3B,3D,4B,4D) revealed significantly the highest mean bond strengths. While the subgroups (1A,1C) recorded the lowest means. In the apical third, the subgroups (4D,1A) yielded the highest and the lowest mean bond strengths respectively.

Irrespective to the resin cements, the mean bond strength of each final irrigation solution at different post space regions with Duncan's multiple rang test shown in (Table 4). Duncan's multiple rang test represented that the use of NaOCl+EDTA+DW yielded significantly the highest mean bond strength in all thirds, but with no statistically significant difference from that result showed with EDTA+DW group in the middle and apical thirds. The control group showed the lowest bond strength that was not statistically significantly difference from that recorded for NaOCl group in all thirds.

Table (4): The mean and standard deviation of push out bond strengths in MPa at three post space thirds with Duncan's multiple rang test for the effect of final irrigation regime

Groups	N	Coronal	Middle	Apical
DW	20	12.36±1.68 ^c	8.12±2.49 ^d	5.23±0.56 ^c
NaOCl+DW	20	12.49±1.60 ^c	9.04±1.38 ^{cd}	5.32±0.38 ^c
EDTA+DW	20	15.19±3.07 ^b	11.39±2.20 ^{ab}	6.65±0.81 ^{ab}
NaOCl+EDTA+DW	20	17.74±2.45 ^a	12.36±2.08 ^a	7.55±1.86 ^a
Total	80	14.48±3.15 ¹	10.23±2.67 ²	6.19±1.34 ³

DW= distilled water NaOCl= sodium hypochlorite EDTA= ethelyndiamintetraacetic acid
Different letters indicated significant differences in each column at (p=0.05) , Different numbers indicated significant differences in the row at p=(0.05).

Irrespective to the final irrigation solutions used, the mean bond strength of each resin cement at different post space regions with Duncan's multiple rang test shown in (Table 5). Duncan's multiple rang test showed that Luxacore®Z Dual

showed the highest bond strength value compared with the other resin cements in all thirds. Although, it was not statistically significant difference from PermaCem®-Dual bond strength value in the middle and apical thirds. While Vivaglass®Liner

revealed the lowest bond strength in all thirds but with no statistically significant difference from the bond strength showed

by Variolink II in the middle and apical thirds.

Table (5): The mean and standard deviation of push out bond strengths in MPa at three postspace thirds with Duncan's multiple rang test for the effect of resin cement types.

Groups	N	Coronal	Middle	Apical (NS)
Vivaglass®Liner	20	11.69±1.74 ^d	8.35±1.42 ^c	5.75±0.88 ^b
PermaCem®-Dual	20	15.52±2.54 ^b	11.09±2.73 ^{ab}	6.51±1.20 ^a
Variolink II	20	13.55±2.26 ^c	8.85±1.63 ^c	5.76±0.99 ^b
Luxacore®Z Dual	20	17.25±2.84 ^a	12.62±2.06 ^a	6.60±1.21 ^a
Total	80	14.48±3.15 ¹	10.15±2.57 ²	6.20±1.21 ³

Different letters indicated significant differences in each column at (p=0.05) , Different numbers indicated significant differences in the row at p=(0.05).

On the effect of post space region on push-out bond strength, the coronal third presented higher mean bond strength then followed by the middle third, while the apical third showed the lowest mean bond strength.

The failure modes recorded were 100% adhesive in nature (Figure 6: a), except in the subgroups (3D,4D) in the coronal third showed (4%, 6%) respectively mixed failure (Figure 6: b,c), no cohesive failure was observed in the presented study.

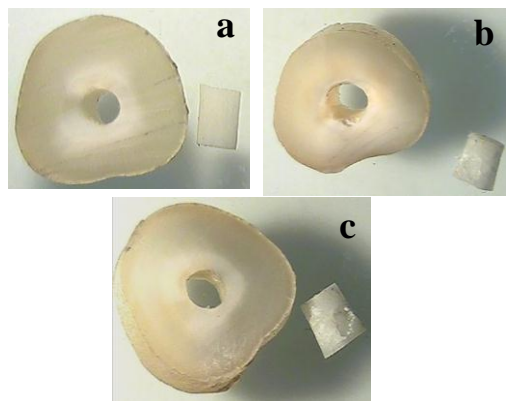


Figure (6): Digital photograph at x20 showing (a) Adhesive failure (b,c) mixed failure.

DISCUSSION

In the present study, the regional bond strength of different types of resin cement to post space dentin after irrigation with different irrigating solutions regimens were investigated.

In this study, the bond strengths of the tested resin cements differently affected by the various irrigation regimens applied. The use of 5.25% NaOCl+17% EDTA+DW as irrigation regimen resulted in higher bond strength value than other irrigating regimens. Studies^(3,6,7,10,11,16) investigating smear layer removal have shown that the most effective mean of smear layer removal involve a combination of EDTA and NaOCl to remove both inorganic and organic components in which it is total removal improves the adaptation of filling materials to the root canal. Also, studies^(6,8,9,11,12) show that the use of EDTA as a final irrigating will produce a strong resin-dentin bond strength and this may be due to 3-phase hybridization between the collagen fibrils, adhesive monomer and demineralized hydroxyapatite bound to exposed collagen fibril.

In the present study, the control group showed the lowest bond strength, which was not significantly difference from that recorded for NaOCl group. Studies^(11,16) showed that distilled water had the highest surface tension values, whereas those of NaOCl and EDTA were relatively low therefore penetrate the dentinal tubule better than distilled water.

Problem of NaOCl if used in association with resin based material is that its strong oxidizing properties which leave dentin surface characterizing by an oxygen rich layer that cause strong inhibition of the interfacial polymerization of resin bonding materials and can significantly reduce bond strength. The generation of

oxygen bubbles at the resin-dentin interface may also interfere with resin infiltration into the tubules and intertubular dentin in addition studies show that NaOCl in high concentration may cause dentin collagen destroyed due to fragmentation of peptide chain.^(4,6,9,10,12,13)

In this study, Luxacore®Z Dual cement showed the excellent bond strength. Studies^(14,15) showed that dual-cured composite resin built-up materials have better mechanical properties and could resist the occlusal load and other stresses generated by chewing force better than dual-cured resin cements.

Vivaglass®Liner revealed the lowest bond strength. Studies⁽¹⁻³⁾ showed that the application of self-adhesive resin cement to radicular dentin does not result in the formation of hybrid layer or resin tags when used for post cementation. In addition, hand mixing produces a lack of consistency in the physical properties of set materials, also porosities may be induced by incorporation of air bubbles into the materials. Studies^(5,17) showed that the injection technique used to deliver the luting cement into the canal produced less air bubbles and voids in all the samples.

In this study, the coronal third promoted higher bond strengths while the apical third recorded lowest bond strengths independently of the final irrigation regimes and adhesive cements. Many studies^(1,5,7,8,15,16) recorded reduction of bonding ability toward apical third of root canal dentin. This is may be due to the higher density of dentinal tubules, longer and greater number of resin tags in the coronal area as well as better accessibility during the bonding procedure and benefits largely from both light and self-curing, as they are readily accessible to the curing light. While in deeper regions debris removal, wet control, and adhesive system application are critical because of access that is more difficult and a possible limitation of cement flow, reduction in curing light transmission could account for decrease in the polymerization of luting cement, which can contribute to the lower bond strengths to dentin.

The mode of failure was mostly adhesive in nature, this suggested that interfacial adhesion was the weakest between

dentin and cement, which was in accordance with other published results.^(2,4,5,15)

CONCLUSIONS

Within the parameters of the current study, the following conclusions can be drawn. The use of NaOCl and EDTA in combination as a final post space irrigation can potentially modify the root canal dentin and increase the bond strength of resin cements to radicular dentin. The use of dual-cured composite resin built-up material for post cementation may assure reliable mechanical properties even in deep regions where light is not available than resin cements. The regional bond strength decreased from coronal to apical direction. The mode of failure was mostly adhesive in nature.

REFERENCES

1. Monticelli F, Ferrari M, Toledano M. Cement system and surface treatment selection for fiber post luting. *Med Oral Pathol Oral Cir Bucal*. 2008;13: E214-22.
2. Bitter K, Paris S, Pfuertner C, Neumann K, Kielbassa AM. Morphological and bond strength evaluation of different resin cements to root dentin. *Eur J Oral Sci*. 2009; 117: 326-333.
3. Bandéca MC, Kassem AS, El-Mowafy O, Nadalin MR, Queiroz RS, Clavijo VR, Saad JR. Influence of storage times on bond strength of resin cements to root canal. *Mater Res*. 2010; 13: 25-28.
4. Ari H, Yasar E, Belli S. Effects of NaOCl on bond strengths of resin cements to root canal dentin. *J Endod*. 2003; 29: 248-251.
5. Mazzitelli C, Monticelli F. Evaluation of the push-out bond strength of self-adhesive resin cements to fiber posts. *Inter dent*. 2009; 11: 54-60.
6. Grand N, Plotino G, Falanga A, Pomponi M, Somma F. Interaction between EDTA and sodium hypochlorite: A nuclear magnetic resonance analysis. *J Endod*. 2006; 32: 460-464.
7. Serafino C, Gallina G, Cumbo E, Ferrari M. Surface debris of canal walls after post space preparation in endodontically treated teeth: a scanning electron microscopic study. *Oral Surg Oral Med Oral Pathol Oral Radiol and Endod*. 2004; 97: 381-387.

8. Putzer P, Hoy L, Günay H. Highly concentrated EDTA gel improves cleaning efficiency of root canal preparation in vitro. *Clin Oral Invest.* 2008; 12: 319–324.
9. Kandaswamy D, and Venkateshbabu N. Root Canal Irrigants. *J Conserv Dent.* 2010; 13: 256-264.
10. Cecchin D, Farina AP, Galafassi D, Barbizam BVJ, Corona SAM, Júnior BC. Influence of sodium hypochlorite and EDTA on the microtensile bond strength of a self-etching adhesive system. *J Appl Oral Sci.* 2010; 18: 385-389.
11. Yilmaz Z, Buzoglu HD, Gümüşdere-lioglu M. Effect of low-surface-tension EDTA solutions on the wettability of root canal dentin. *Oral Surg Oral Med Oral Pathol Oral Radiol and Endod.* 2011; 3: 109-114.
12. Kim D, Prak S, Choi G, Choi K, Kim S. Effect of EDTA treatment on the hybrid layer durability in total-etch dentin adhesives. *Dent Mater J.* 2011; 30: 717-722.
13. Prasansuttiporn T, Nakajima M, Kun-awarote S, Foxton R, Tagami J. Effect of reducing agents on bond strength to NaOCl-treated dentin. *Dent Mater.* 2011; 27: 229–234.
14. Arrais CA, Kasaz A, Albino L, Rodrigues J, Reis A. Effect of curing mode on the hardness of dual-cured composite resin core build-up materials. *Braz Oral Res.* 2010; 24: 245-249.
15. Aksornmuang J, Nakajima M, Foxton RM, Tagami J. Mechanical properties bond strength of dual-cure resin composites to root canal dentin. *Dent Mater.* 2007; 23: 226-634.
16. Giardino L, Ambu E, Becce C, Rimondini L, Morra M. Surface tension comparison of four common root canal irrigants and two new irrigants containing antibiotic. *J Endod.* 2006; 32: 1091-1093.
17. Yahya NA, Lui JL, Chong K, Lim C, Abu kasim N, Radzi Z. Effect of luting cement to push-out bond strength of fiber reinforced post. *Annal Dent Univ Malaya.* 2008;15: 11-19.