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EFFECT OF DIFFERENT ENDODONTIC IRRIGATION SOLUTIONS ON THE RETENTION OF A FIBER POST CEMENTED WITH A SELF-ADHESIVE RESIN CEMENT TO ROOT DENTIN

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Keywords: root canal irrigants, resin cement, fiber post, dental bonding.

Summary
The aim of this study to systematically review the literature using *in vitro* studies to investigate if cleaning post-space preparation with different irrigants can increase the retention of fiberglass post evaluated by push-out test. The present systematic review reports the results according to guidelines of PRISMA statement. The research question was developed according to the PICO strategy. Two electronic databases including PubMed and Ovid (MEDLINE) were used to find relevant studies. Two reviewers independently screened titles and abstracts through the databases and performed evaluation of risk of bias of the included studies. After study selection, only 11 studies met the inclusion criteria and were included in the systematic review. There was significant heterogeneity in the methodological variables, and therefore, it was impossible to perform valid quantitative synthesis of the data (meta-analysis). Insufficient evidence was found to indicate any of the irrigation solutions used to their effect on bond strength of self adhesive resin cement to root dentin. It is impossible to conclude recommendations to a specific irrigation protocol. Future studies should follow a standardized approach to implementation, same methodologies and reporting of data. Recommendations have been provided for standard methods of future studies so that clinical recommendations could be provided.

Introduction

Endodontic posts are often necessary in restoring endodontically treated teeth with excessive dental structural loss due to caries, fractures or endodontic access cavity preparations [1]. In recent years fiberglass posts have been often used and preferred over prefabricated metallic posts because of their similar physical properties to dentin. These physical properties include elastic modulus and flexural strength, which reduce the incidence of root fracture, and have advantages, such as aesthetics, biocompatibility and absence of corrosion risk [2,3].

The most commonly reported clinical failure in fiberglass post is debonding from the root canal at the dentin-resin cement interface [4,5,6]. The major factors influencing the bond strength of resin cement are the root canal shape, depth of the intraradicular area, orientation of dentinal tubules, irrigation solutions, negative C-factor, difficulty in access and moisture control, type of adhesive system, and endodontic sealer [7,8].

Conventional and self-adhesive resin cements are currently used to lute fiberglass posts to root dentin. Conventional resin cements associated with dentin pretreatment with etch and rinse adhesive systems have demonstrated good results, however, self-adhesive resin cements appeared as an alternative to avoid the pretreatment requirements for the root dentin and has no negative effects on the root canal resulting from either chemical or micromechanical retention to the tooth surface [9].

Canal preparation for post procedures creates a smear layer on the root canal dentin surface that directly affects the bond strength of the self-adhesive cement to the root dentin. Self-adhesive resin cement is unable to etch the root canal dentin through the smear layer or to form a hybrid layer and resin tags. Self-adhesive resin cements adhesion is based on the chemical interactions between acidic hydrophilic monomers and hydroxyapatite, which modifies the smear layer, and on micromechanical retention [10,11].

Post space irrigation may influence the strength of the

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cement bond with the root canal dentin by removing remaining sealer, ghutta percha and smear layer. Sodium hypochlorite, ethylenediaminetetraacetic acid, phosphoric acid, and chlorhexidine are the most routinely used agents [12,13].

The aim of this study was to systematically review the literature using *in vitro* studies and to summarize the outcomes of different irrigation solutions and their effect on bond strength of self-adhesive resin cement to root dentin. The null hypothesis states that cleaning the post-space with different irrigation solutions would not effect the bond strength of self-adhesive resin cement to root dentin. The research question was developed and investigated as follows: Do the irrigating of post-space with different irrigation solutions influence the retention of a fiberglass post evaluated by push-out test?

Material and Methods

The present systematic review reports the results according to the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement [14].

A PICO question was developed as follows: "Population" included study groups with extracted human teeth, "Intervention" was the evaluation of different irrigation solutions to clean post space, "Comparison" was the evaluation of irrigation with saline or distilled water, and the "Outcome" evaluated was the bond strength of self-adhesive resin cement to root dentin assessed by the push-out test.

Criteria for study selection. The studies had to meet the following requirements: *in vitro* studies using human teeth; the push-out test must have been used to evaluate the bond strength of the self-adhesive resin cement to root dentin; a fiberglass post had to be used and cemented with self-adhesive resin cement; the post space was cleaned by irrigation solutions before cementing the fiberglass post; publications must be reported in the English peer-reviewed dental literature.

The exclusion criteria were as follows: studies that used non- human teeth; other than the push-out test was used to evaluate cement bond strength to root dentin; use of eugenol endodontic sealer; use of any other canal cleaning method before irrigating the post space or during irrigation procedure.

Studies Selection and Data Extraction. Two reviewers (ES and RS) independently screened titles and abstracts through the databases. Any discrepancies were solved through consensus between the reviewers or by arbitration (GZ). Data from the selected studies were selected independently by three reviewers (ES, RS, and GZ).

The following data was extracted from selected studies: authors and year of publication; type of study; number of teeth used; storage after extraction; root canal preparation prior to preparing post space; post space preparation methods and materials used; period before post cementation-time and storage conditions; endodontic sealer used; type of cement used; irrigating solutions used to clean the post space prior to cementation.

Literature Search. Two electronic databases including PubMed and Ovid (MEDLINE) were used to find relevant studies using the search terms: ("Root Canal Irrigants"[Mesh]) OR "Root Canal Preparation"[Mesh]) AND "Post and Core Technique"[Mesh]) AND "Bond Force dental cement" [Supplementary Concept]) OR "Cementation"[Mesh]) OR "Dental Cements"[Mesh]) OR "Dental Bonding"[Mesh]) OR "Dentin-Bonding Agents"[Mesh]) OR "Dentin"[Mesh]). Articles restricted to the English language were considered with restriction of publication periods from December 2019 up to February 2020. The examiners evaluated titles and abstracts of all identified studies. When the abstract did not contain sufficient information to enable a decision on inclusion or exclusion, the full manuscript was evaluated before the final decision. Studies that appeared in more than one evaluated database were considered only once.

Outcomes. The outcome was cement bond strength to root dentin evaluated using push-out test and expressed in MPa.

Risk of bias (quality assessment). The risk of bias table was formulated by two reviewers based on the Joanna Briggs Institute Clinical Appraisal Checklist for Experimental Studies as described in previously published studies [15,16]. The risk of bias was marked "+" which equaled to "1" when the details of the parameters were mentioned with no ambiguity. When there was ambiguity or if no details were mentioned, it was marked as "-" which equaled to "0". The scored points were added together. Methodologic quality was low if 1-4 points, moderate - if 5-7 points, and high - if 8-10 points were counted (Table 1).

Results

There was significant heterogeneity in the methodological variables, and therefore, it was impossible to perform valid quantitative synthesis of the data (meta-analysis). Therefore, a descriptive presentation of the data was performed.

Study selection. Article review and data extraction were performed according to the PRISMA flow diagram (Figure 1). The initial electronic search found a total of 52,381 articles, 37,490 of which were eliminated as duplicates or older than ten years publications. After titles and abstracts were reviewed, an additional 14,771 articles were filtered as not relevant studies, systematic reviews or not having enough information regarding selecting topic. 95 articles were iden-

tified as full-text articles, of which only 11 were included in this review [17-27].

Study characteristics. A total of 708 human teeth were used, the most frequent being premolars (46.3%), anterior teeth were used in three studies (24%), other studies did not mention the exact amount of teeth used (29.7%). The most popular endodontic sealers used in the studies was AH Plus (Dentsply), which was used in four studies [17,20,21,24], Sealer-26 (Dentsply) was used in four studies [18,22,25,26], AH-26 (Dentsply) was used in two [19,23], and Sealaplex sealer (Kerr) was used in one study [27]. The timing of post-space after obturation revealed was seven days in most studies [17,18,20,21,23-27], in one study teeth after obturation were stored for three days [22], another study did not even mention the timing after obturation [19]. The most used cement was Relyx U200 (3M ESPE), which was mentioned in six studies [17,1821,24-27], Relyx U100 [18], Relyx Unicem (3M ESPE) [22], BisCem (Bisco inc.) [23], iCEM (Heraeus Kulzer) [20], Multilink Speed (Ivoclar Vivadent) [26], Maxcem Elite (MCE) (Kerr) [27] and Clearfil SA (Kuraray America inc.) [19] were used in separate single studies. In nine of the included studies, the push-out test was applied to different root thirds and differences were evaluated [1-4,6,8-10,11].

Table 1 summarizes the characteristics of the included articles.

Sodium hypochlorite (NaClO). Ten of included studies used sodium hypochlorite as irrigation solution alone [18-27]. There was variability in the duration and concentration of all irrigants. Three studies used 5% NaClO [18,21,22], three of which used NaClO followed by a rinse of distilled water [18,22,26], four studies used 5.25% [20,23,25,27] and 2.5% NaClO, 1% and 6.15% NaClO solutions were used in separate single studies [19,21,23,26]. Five studies used NaClO solution for one minute [22-25,27], one study for three minutes [18], four studies did not mention the exact amount of time irrigation was proceeded for [19-21,26]. There was used between 2 and 10 mL of NaClO. Five studies reported that NaClO significally reduced bond strength [18,19,20,22], two of these studies reported that bond strength was significantly reduced when Multilink Speed and BisCem cements were used compared to control groups [26]. Four included studies reported that bond strength after irrigating with NaClO solution was not significantly different from the control group [22-25]. One of these studies reported that it was not different from the control group when Relyx Unicem cement was used [22]. One of the studies did not even have control group [19]. One study found different results depending on the root part and different cement used [27]. Using Relyx U200 NaClO bond strength was reduced in apical, using MCE - cervical

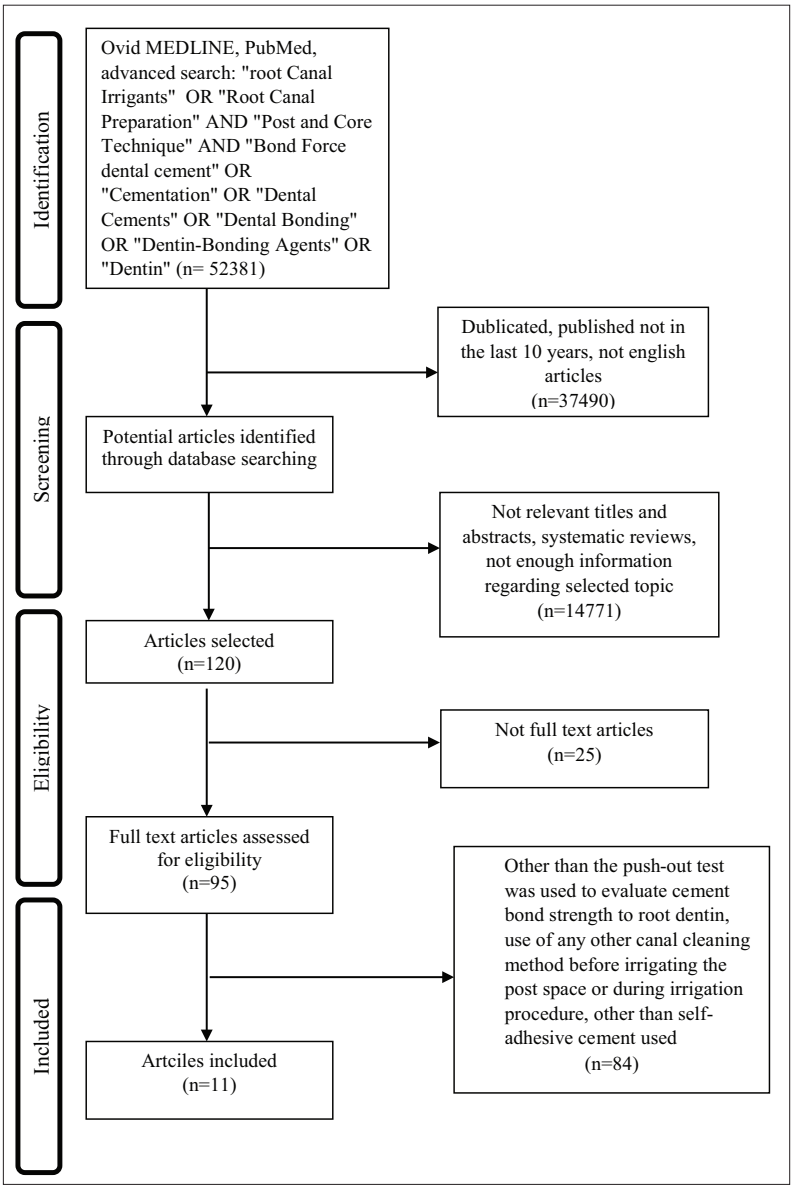

Figure 1. PRISMA flow diagram

and middle parts, Relyx U200 increased the bond strength in cervical and MCE - apical parts. NaClO irrigation solutions did not provide enough conclusive evidence, whether or not they had an effect on bond strength of cement to root dentin.

Ethylenediaminetetraacetic acid (EDTA). Six studies used 2-10mL of 17% EDTA irrigation solution alone [18-20,22,25,26]. Two studies mentioned that it was used for 1 min [22,25]. Three studies used EDTA followed by a rinse of distilled water [18,22,26]. In two studies EDTA increased bond strength, one of which was when BisCem cement was used [20,22]. One study did not have the control group but it showed that EDTA had significantly higher results in cervical and apical root thirds than other experimental groups [19]. In three studies EDTA decreased bond strength [18,22,26], two of which was when Multilink Speed and Relyx Unicem cements were used. In two studies, one of which Relyx U200 cement was used, EDTA results were not significantly different from control group results [25,26]. There was not enough evidence to arrive at any conclusion regarding EDTA solution and its effect on bond strength of cement to root dentin.

Chlorhexidine (CHX). Five studies used 2% chlorhexidine, while one study used chlorhexidine gel [17,20,21,25,27]. There was 5-15 mL of chlorhexidine

Table 1. Characteristics of included studies
NaClO, sodium hypochlorite; CHX, chlorhexidine; PAA, polyacrylic acid; EDTA, ethylenediaminetetraacetic; sec, seconds; min, minutes

Authors, year	Kul et al., 2016	Garcia et al., 2018	Alkhudhairy et al., 2018	Elnaghy et al. , 2013	Seballos et al., 2018	Faria-e-Silva et al., 2012	Khoroushi et al., 2019	F an et al., 2017	Crispim da Silveira. et al., 2014	Jitumori. et al., 2019	Suzuki et al., 2019
Number of samples	40 mandibular premolars	48 mandibular premolars	52 anterior teeth	90 single rooted	80 premolars	48 incisors	40 premolars	60 premolars	70 mandibular incisors	120 single rooted	60 premolars
Storage after extraction	Distilled water	Not mentioned	1% sodium azide	0.5% chloramine T at 4 °C	0.9% saline solution at 4°C	Not mentioned	0.2% thymol solution	0.2% sodium azide	Not mentioned	Not mentioned	Kept frozen (-20 °C)
Canal preparation	1. ProTaper NiTi 2. Gutta percha	1. K files 2. Gutta percha	1. K files, ProFile series 29 system 2.Gutta percha	1. ProTaper system 2. Gutta percha	1. ProTaper Universal 2. Gutta percha	1. K files, Gates-Glidden drills 2. Gutta percha	1. K files and Gates-Glidden 2. Gutta percha	1. ProTaper Universal 2. Gutta percha	1. Gates Glidden drills 2. Gutta percha	1. ProTaper system 2. Gutta percha	1. Instruments used unknown 2. Gutta percha
Endodontic sealer	1. Resin based 2.AH Plus sealer	1. Non-eugenol resin sealer 2. Sealer-26	1. Resin based 2.AH 26 sealer	1. Resin based 2.AH Plus sealer	1. Resin based 2.AH Plus sealer	1. Non-eugenol resin sealer 2. Sealer-26	1. Resin based 2. AH26 sealer	1. Resin based 2. AH Plus sealer	1. Non-eugenol resin sealer 2. Sealer-26	1. Non-eugenol resin sealer 2. Sealer-26	1. Calcium hydroxide cement 2 Sealaplex
Storage after canal obturation	1. 100 % humidity 2. 37 °C 3. 7 days	1. 100 % humidity 2. 37 °C 3. 7 days	None	1. 100 % humidity 2. 37 °C 3. 7 days	1. 100 % humidity 2. 37 °C 3. 7 days	1. 100 % humidity 2. 3 days	1. 100 % humidity 2. 37 °C 3. 7 days	1. 100 % humidity 2. 37 °C 3. 7 days	1. 100 % humidity 2. 37 °C 3. 7 days	1. 100 % humidity 2. 37 °C 3. 7 days	1. 100 % humidity 2. 37 °C 3. 7 days
Post-space preparation	1. #1 Peeso reamer 2. #1 drill (DT Light-Post System)	1.Low-speed drill (White Post – DC 2; FGM-Dentscare)	1. Hot pluger, sequential reamers (ParaPost Fiber Lux)	1. Preshaping drill (Rebilda post; VOCO).	1. #2,3,4 Largo drills (Dentsply Mailleifer), the Exacto Translúcido AngelusN2 (Angelus) bur	1. Epoxy post system kit drills (White Post DC3; FGM)	1. Peeso reamers 2. Post system drill (Series 911, Conical Type 2°, Micro.Medic)	1.Preshaping post drill (3M ESPE)	1.#4 Gates Glidden drill 2. #5 Largo drill (Ângelus Ind..)	1. Post drill Whitepost DC #2 (FGM-Dentscare)	1.# 2, 3, 4, 5 low-speed drill bit (Dentsply Maillefer) sequentially
Cement	RelyX U200 (3M ESPE)	RelyX U100 (3M ESPE)	Clearfil SA cement (Kuraray America)	i Cem (Heraeus Kulzer)	RelyX U200 (3M ESPE)	RelyX Unicem clicker (3M ESPE) and BisCem (Bisco Inc.)	BisCem cement (Bisco Inc.)	Rely X U200 (3M ESPE)	Rely X U200 (3M ESPE)	RelyX U200 (3M ESPE) and Multilink Speed (Ivoclar Vivadent)	Rely X U200 (3M ESPE) and Maxcem Elite (MCE) (Kerr)
Post	Not mentioned	White Post DC 2 (FGM-Dentscare)	A size #6, parallel-sided (ParaPost Fiber Lux)	Rebilda post (VOCO), size Ø 1.5	Exacto Translúcido N2 (Angelus)	Epoxy post system (White Post DC3; FGM)	Glass fiber post (Micro.Medica s.r.l.,)	3M ESPE post	Reforpost (Ângelus Ind.)	Whitepost DC 2 (FGM-Dentscare)	#3 glass fiber post system (Reforpost; Angelus)
Control group	Distilled water 15 mL	Distilled water 10 mL for 3 min	None	Sterile distilled water 5 mL	0.9% saline solution	No solution used	0.9% normal saline	0.9% normal saline solution 5mL for 1 min	Saline solution for 1 min	Distilled water 5 mL	Distilled water

Experimental groups	1. 5.25% NaClO + 17% EDTA 5 mL each for 1 min + 5 mL of distilled water 2. 15 mL of a 2% CHX solution 3. 35% Phosphoric acid for 15 sec + 15 ml of distilled water	1. 5% NaClO + distilled water 10 mL each for 3 min 2. 17% EDTA + 5% NaClO + distilled water 10mL each all for 3 min 3. 17% EDTA + distilled water 10 mL each both for 3 min	1. 6.15% NaClO 2. 17% EDTA 3. 6.15% NaClO + 17% EDTA 4. 0.12% CHX + 6.15% NaClO 2 mL of each	1. 5.25% NaClO 2. 2% CHX 3. 17% EDTA 4. 17% EDTA + 2% CHX 5. QMix (Dentsply Tulsa Dental). 5 mLof each	1. 2% CHX 2. 1% NaClO 3. 2.5% NaClO, 4. 5% NaClO, 5. 1% CaClO, 6. 2.5% CaClO 7. 5% CaClO	1. 11.5% PA for 30 sec, 2. 17% EDTA for 60 sec 3. 5% NaClO for 60 sec.	1. 2.5% NaClO, 2. 5.25% NaClO, 3. 2.5% CaClO 4. 5% CaClO. Each 5 mL for 60 seconds	1. 5 mL of 2.5% NaClO for 1 min 2. 17% EDTA + 2.5% NaClO each 5 mL for 1 min 3. 5 ml of 7% MA for 45 sec + 5 ml of 2.5% NaClO for 1 min	1. 5.25% NaClO for 1 min + 17% EDTA for 3 min 2. 5.25% NaClO for 1 min 3. 17% EDTA for 1 min 4. 2% CHX gel for 1 min 5. 70% Ethanol for 1 min 6. Polyacrylic acid for 30 sec	1. 5 ml of 2.5% NaClO; 2. 5 ml of 17% EDTA 3. 2 drops (ca 0.25 ml) of 26% PAA 4. 5 ml of 17% EDTA + 5 ml of 2.5% NaClO. Final rinse 15 mL of distilled water for all groups	1. 5.25% NaClO 2. 25% PAA 3. 2% CHX 4. 23 ppm silver nanoparticles dispersion 5 ml each for 60 sec
Time and storage after post cementation	1. 100% humidity 2. 37 °C 3. 1 day	1. 100% humidity 2. 37 °C 3. 1 day	1. 100% humidity 2. 7 days	1. 100% humidity 2. 37 °C 3. 7 days	1. 37 °C 2. 2 days	1. 100% humidity 2. 37 °C 3. 7 days	1. 100% humidity 2. 37 °C 3. 24 hours	1. 100% humidity 2. 37 °C 3. 7 days	1. 10 mL of deionized water 2. 37 °C 3. 1 day	1. 100% humidity 2. 37 °C 3. 7 days	1. Thermal cycling 2. 7 days
Analysis of teeth	Push-out test at 0,5 mm/min applied to root thirds	Push-out test at 0,5 mm/min applied to root thirds	Push-out test at 1 mm/min applied to apical and cervical parts	Push-out test at 0,5 mm/min applied to root thirds	Push-out test at 0,5 mm/min applied to root thirds	Push-out test at 0,5 mm/min applied to root thirds	Push-out test at 0,5 mm/min	Push-out test at 0,5 mm/min applied to root thirds	Push-out test at 0,5 mm/min applied to root thirds	Push-out test at 0,5 mm/min	Push-out test at 0,5 mm/min applied to root thirds

used, only one study mentioned that they used it for 1 minute [25]. One study used CHX followed by a rinse of distilled water [17]. In two studies there was a significant increase of bond strength reported [20,27]. One study reported significantly decreased bond strength [21]. One study showed that it increased bond strength when Relyx U200 cement was used [27], but it was not significantly different from the control group in the other three studies, one of which was when MCE cement was used [17,25,27]. There was not enough evidence to arrive at any conclusion regarding CHX solution and its effect on bond strength of cement to root dentin.

Polyacrylic acid (PAA). Four studies included polyacrylic acid (PAA) in one of the experimental groups [22,25-27]. 11.5%, 26%, 25% PAA was used, one study did not mention the concentration of the solution. 0.25 to 5 mL of PAA was used between 30 to 60 seconds. Two studies used PAA followed by a rinse of distilled water [22,26]. PAA decreased bond strength in three studies [22,26,27]. In one of which it was decreased when BisCem and Relyx Unicem cements were used. PAA did not change bond strength compared to control groups in two studies [22,25]. In one study it decreased bond strength when MCE was used in cervical, but did not change the bond strength in middle and apical thirds [27]. There was not enough evidence to arrive at any conclusion regarding PAA solutions and their effect on bond strength of cement to root dentin.

Combination of solutions. NaClO and EDTA combination in different concentrations, amount, sequence, and duration was used in six studies [17-19,24-26]. It increased bond strength in three studies, decreased in one study and was not significantly different from the control group in two studies. Therefore, there was not enough evidence to arrive at any conclusion regarding these irrigatin solutions and their effect on bond strength of self- adhesive resin cement to root dentin. Three studies used a combination followed by a rinse of distilled water [17,18,26]. 2.5 % NaClO and 7 % Maleic acid 5mL each for 1 min combination was used in one study and it showed to increase bond strength compared to the control group [24]. 17% EDTA and 2% CHX 5 mL each were used in combination and it significantly increased bond strength in one study [20].

Ethanol. In one of the included studies 70% Ethanol was used for 1 min, which significantly increased bond strength when compared to the control group, however, no significant differences were found among root thirds [25].

QMix. One study showed that 5 mL of QMix significally increased bond strength after 1 week in all root thirds compared to the control group [20].

Calcium hypochlorite (CaClO). CaClO was used in two of the included studies, both of which used 2.5% and 5% respectively. One of these studies also evaluated 1% CaClO. Khouroushi et al. study used 5mL of CaoCl for one minute, while another study did

not mention duration and amount of CaClO used. Seballos study showed that CaClO reduced bond strength compared to the control group, no significant differences were found between concentrations. In Khouroushi et al. study only 5% CaClO solution statistically increased bond strength [21,23].

Phosphoric acid. One study used 35% Phosphoric acid for 15 seconds followed by a rinse of 15 mL of distilled water. Study showed that no statistically different result was found between Phosphoric acid and control groups and root thirds [17].

Silver nanoparticles. Thais Y.U. et al. used 23 ppm silver nanoparticles dispersion which increased bond strength for Relyx U200 in cervical and for Maxcem Elite cement in middle root third, decreased for Relyx U200 in apical and for Maxcem Elite in cervical root third. Bond strength in other root thirds for both cements were not significantly different from the control group 1 week after canal obturation [27].

Risk of bias within studies. All of the studies that were included in the review were as-

Table 2. Risk of bias of included studies

	Kul et al., 2016	Garcia et al., 2018	Alkhudhairy et al., 2018	Elnaghy et al., 2013	Seballos et al., 2018	Faria-e-Silva et al., 2012	Khouroushi et al., 2019	Fan et al., 2017	Crispim da Silveira. et al., 2014	Jitumori. et al., 2019	Suzuki et al., 2019
Were teeth assigned to groups truly randomly?	-	+	+	+	-	-	+	+	+	+	+
Were participants blinded to teeth treatment assignment?	-	-	-	-	-	-	-	-	-	-	-
Were the assignment of teeth to treatment groups blinded from the assignor?	-	-	-	-	-	-	-	-	-	-	-
Were the outcomes of people who withdrew described and included in the analysis?	-	-	-	-	-	-	-	-	-	-	-
Was the outcome assessors blind to treatment assignment?	-	-	-	-	-	-	-	-	-	-	-
Were all the groups comparable at baseline?	+	+	-	+	+	+	+	+	+	+	+
Were the groups treated the same other than the intervention of interest?	+	+	+	+	+	+	+	+	+	+	+
Were the outcomes evaluated the same way for all the groups?	+	+	+	+	+	+	+	+	+	+	+
Were the outcomes evaluated in right way?	+	+	+	+	+	+	+	+	+	+	+
Was an appropriate statistical analysis done?	+	+	+	+	+	+	+	+	+	+	+
Total	5	6	5	6	5	5	6	6	6	6	6

sessed for the risk of bias (Table 2). The overall methodologic quality of studies was moderate. Four studies scored total five points [17,19,21,22], seven studies - six points [18,20,23-27]. In three of the studies, the assignment to groups either was not truly random, or not clear [17,21,2]. The nature of the studies did not allow for participants to be blinded to treatment allocation in any of the included studies. One study did not have a control group [19]. Those who were assessing the outcomes were not blinded to treatment allocation and allocation to treatment groups were not concealed from the allocator in any of the included studies.

Discussion

This aim of this systematic review was to evaluate the influence of irrigation solutions on the bond strength of self-adhesive resin cement to root dentin. It is important to understand the effect of irrigation solutions on the bond strength of self-adhesive resin cement to root dentin because irrigants described in this review are periodically used in everyday clinical practice. There was a heterogeneity in the study because of different methodologies of the articles evaluated which did not allow to do a meta-analysis, nevertheless some important conclusions could be made from the outcomes.

70% ethanol, Qmix, 5% CaClO, 35% Phosphoric acid, 23 ppm silver nanoparticles, 2,5% NaClO/7% Maleic acid and 17 % EDTA/2% CHX were evaluated in single studies and they all significantly increased the bond strength of self-adhesive resin cement to root dentin. However, moderate methodologic quality of all studies and not enough of studies that evaluate mentioned irrigants and their effect on the bond strength of self-adhesive resin cement to root dentin done indicate not enough evidence to draw a conclusion from results regarding these irrigation solutions and their effect on the bond strength of self- adhesive resin cement to root dentin.

In studies that evaluated NaClO, EDTA, CHX, PAA irrigants and their combinations methodologies varied. These studies used different type of teeth, concentrations, amount, volume of irrigants, cements, post, sealers, type of instruments for canal preparation and post preparation. Therefore, there was conflicting evidence in the results, and no evidence was found for the irrigation solutions effecting bond strength of self-adhesive resin cement to root dentin. For this reason, push-out test values are incomparable and have not been discussed. It is offered to that the methods of testing must be standardized to allow comparison of data and provide clinical recommendations.

Despite the restrictions of this review mentioned above this review has other restrictions too. One of them is this review includes *in vitro* studies, which gives less reliable results than randomized- control studies, nevertheless well-done and designed *in vitro* studies can also give favorable results. Another restriction is that in none of the studies operators who were assessing the outcomes were blinded to treatment allocation. Allocation to treatment groups were not concealed from the allocator in any of the studies and that increased risk of bias of the included studies.

Based on this review, that the papers evaluating irrigation solutions and their effect on bond strength of self-adhesive resin cement to root dentin should report following details: randomization of specimens, standardized protocol: root canal preparation methods and materials, duration of irrigation procedure, concentration and volume of irrigants, storage methods, posts and cements used, blinding of evaluator. Furthermore, a single participant must perform all procedures in canal while the push-out test should be done by the other operator who is blinded to experimental groups.

Conclusion

The results of this systematic review demonstrated the lack of standardization in both the method and the reporting of data on effect of irrigation solutions on bond strength of self-adhesive resin cement to root dentin. It is impossible to conclude recommendations to a specific irrigation protocol. Future studies should follow a standardization approach to implementation, same methodologies and reporting of data.

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SKIRTINGŲ ENDODONTIJOJE NAUDOJAMŲ IRIGACINIŲ TIRPALŲ ĮTAKA STIKLO PLUOŠTŲ, CEMENTUOJAMŲ SAVAIMINIO ĖSDINIMO DERVINIAIS CEMENTAIS, RETENCIJAI

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Raktažodžiai: šaknų kanalų irigaciniai tirpalai, dervinis cementas, stiklo pluošto kaištis, danties sukibimas

Santrauka

Šios literatūrinės apžvalgos tikslas buvo atrinkti, išanalizuoti ir susisteminti mokslinių tyrimų in vitro rezultatus apie skirtingų irigacinių tirpalų įtaką stiklo pluoštų kaiščių, cementuojamų savaiminio ėsdinimo derviniais cementais, retencijai. Retencija turėjo būti vertinama išstūmimo testu. Ši mokslinės literatūros sisteminė apžvalga buvo atlikta, taikant PRISMA reikalavimus. PICOS metodas

buvo panaudotas duomenų, iš atrinktų publikacijų, surašymui. Dvi elektroninės duomenų bazės (PubMed, Ovid (MEDLINE)) buvo panaudotos straipsnių paieškai ir atrinkimui. Straipsnių atranką ir atrinktų publikacijų metodologinės kokybės vertinimą atliko du nepriklausomi tyrėjai. Į mokslinės literatūros sisteminę analizę viso buvo įtraukta 11 įtraukimo kriterijus atitinkančių publikacijų. Dėl skirtingų tyrimo metodų, pateiktų publikacijose, metaanalizės atlikti buvo neįmanoma. Skirtingos tyrimų metodikos, rezultatai ir nevienodos pateiktos išvados atrinktose publikacijose neleido sudaryti tikslių išvadų apie skirtingų irigacinių tirpalų efektą stiklo pluoštų, cementuojamų savaiminio ėsdinimo derviniais cementais, retencijai. Dėl šios priežasties nėra galima pateikti klinikinių rekomendacijų irigacijos protokolui. Tolimesnės studijos, turinčios standartizuotą tyrimo metodą, vienodą rezultatų pateikimą, reikalingos atlikti ateityje. Pateiktos rekomendacijos tokių studijų metodikų suvienodinimui ir klinikinių rekomendacijų pateikimui.

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