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Do irrigation solutions used during root canal instrumentation influence the adhesion of glass fiber posts? A systematic review

As soluções de irrigação usadas durante a instrumentação do canal radicular influenciam a adesão de pinos de fibra de vidro? Uma revisão sistemática

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ABSTRACT

Statement of problem: the bond strength between adhesive cement and root dentin can be affected by irrigation protocols. **Purpose:** therefore, the objective of this systematic review was to answer the following question: Do irrigation solutions used during root canal instrumentation influence the adhesion of glass fiber posts to root dentin? **Material and Methods:** this study followed the recommendations of PRISMA 2020 for writing. PubMed, Scopus, Web of Science, and LILACS databases were searched for articles published until 26 January, 2022. Grey literature and a manual search were also performed. The inclusion criteria were based on the PICO strategy: permanent human or animal teeth (P), which were irrigated during root canal instrumentation with endodontic substances (I) and compared to irrigation with sodium hypochlorite at various concentrations (C) to analyze the bond strength of glass fiber posts (O). Two authors independently performed data extraction and the risk of bias. **Results:** eight articles were included. Four articles were classified as having a high risk of bias, where the others as medium risk. Studies have reported conflicting results regarding the influence of irrigating solutions and the different concentrations of sodium hypochlorite on the adhesion of glass fiber posts to root dentin. **Conclusion:** the heterogeneity between studies did not allow the conclusion of a true estimate regarding this topic, and further well-designed studies are needed to clarify this issue. **Register:** CRD42020221835.

KEYWORDS

Bond strength; Dentin; Glass fiber post; Root canal irrigants; Shear strength.

RESUMO

Definição do problema: a resistência de união entre o cimento adesivo e a dentina radicular pode ser afetada pelos protocolos de irrigação. **Objetivo:** portanto, o objetivo desta revisão sistemática foi responder à seguinte questão: As soluções de irrigação usadas durante a instrumentação do canal radicular influenciam a adesão de pinos de fibra de vidro à dentina radicular? **Material e Métodos:** este estudo seguiu as recomendações do PRISMA 2020 para sua redação. As bases de dados PubMed, Scopus, Web of Science e LILACS foram pesquisadas para artigos publicados até 26 de janeiro de 2022. A literatura cinza e uma pesquisa manual também foram realizadas. Os critérios de inclusão foram baseados na estratégia PICO: dentes humanos ou animais permanentes (P), que foram irrigados durante a instrumentação do canal radicular com substâncias endodônticas (I) e comparados à irrigação com hipoclorito de sódio em várias concentrações (C) para analisar a resistência de união de pinos de fibra de vidro (O). Dois autores realizaram independentemente a extração de dados e o risco de viés. **Resultados:**

oito artigos foram incluídos. Quatro artigos foram classificados como de alto risco de viés, enquanto os demais como de médio risco. Estudos relataram resultados conflitantes sobre a influência de soluções irrigadoras e as diferentes concentrações de hipoclorito de sódio na adesão de pinos de fibra de vidro à dentina radicular. **Conclusão:** a heterogeneidade entre os estudos não permitiu a conclusão de uma estimativa verdadeira sobre este tópico, sendo necessários mais estudos bem delineados para esclarecer esta questão. **Registo:** CRD42020221835.

PALAVRAS-CHAVE

Resistência de união; Dentina; Pino de fibra de vidro; Irrigantes do canal radicular; Força de cisalhamento.

INTRODUCTION

The aim of root canal treatment is to prevent or eliminate infection of the root canal system, mainly by shaping and cleaning the canal using files, reamers, irrigation solutions and antibacterial dressings [1]. The most commonly used endodontic irrigation solution is sodium hypochlorite, due to its ability to dissolve organic tissues and high effectiveness in reducing microorganisms in the root canal [2]. Chlorhexidine is a broad-spectrum antiseptic solution that has also been used in endodontic therapy to disinfect root canals or as an intracanal medicament, or even as a final irrigant [3]. Chlorhexidine is less cytotoxic to periapical tissues [3] and is also effective against a variety of Gram-positive and Gram-negative oral bacterial species [4], but its main limitation is the inability to dissolve pulp tissue [5]. However, new substances are being introduced into the root canal to complement conventional chemomechanical procedures [6], such as irrigants associated with surfactants, chelators, tetracyclines [7,8], ozonized water [9], photosensitizers with photodynamic therapy [10], among others.

Teeth with significant coronal destruction and endodontically treated teeth usually require glass fiber posts to improve crown retention or composite resin restorations [11]. Glass fiber posts have several advantages, such as high flexural strength, better distribution of the stress generated, biocompatibility, and corrosion resistance, in addition to an elasticity module close to dentin [12,13]. However, failures can occur, mainly due to failure in adhesion between the adhesive cement and the inner walls of root canals [14].

The bond strength of adhesive cement and dentin can be affected by many factors, such as the presence of root canal treatment, pretreatment of the post, cementation method, and use of irrigation protocols [15,16]. Some studies have reported that the irrigation solutions used during root canal treatment have significant statistical influence on the adhesion of the glass fiber posts to dentin [15,17-20]; however, others do not demonstrate this influence [21-24].

Therefore, some concerns about the influence of endodontic irrigation solutions on the adhesion of glass fiber posts are still significant [25], mainly due to the few existing studies in the literature on the subject and their heterogeneous conclusions. To date, no systematic review has evaluated this relationship. Although a systematic review published in 2015 [16] addressed the factors associated with the adhesion of glass fiber posts, the main objective was to assess the influence of variables related to post-cementation, disregarding the substances used in endodontic irrigation, reaffirming the importance of this study for daily clinical management.

Therefore, the objective of this systematic review was to answer the following question structured according to PICO: Do irrigation solutions used during root canal instrumentation influence the adhesion of glass fiber posts to the root dentin?

METHODS

This systematic review was registered in PROSPERO (CRD42020221835) and followed the recommendations of PRISMA (Preferred Reporting Items for Systematic Review and Meta-Analysis) guidelines for its writing [26].

Search strategy

The electronic databases PubMed, Scopus, Web of Science, and Virtual Health Library (LILACS) were searched for articles published until 26 January 2022, without language, year restrictions or limits. The selection process is illustrated in Figure 1. The grey literature was consulted through OpenGrey, and references

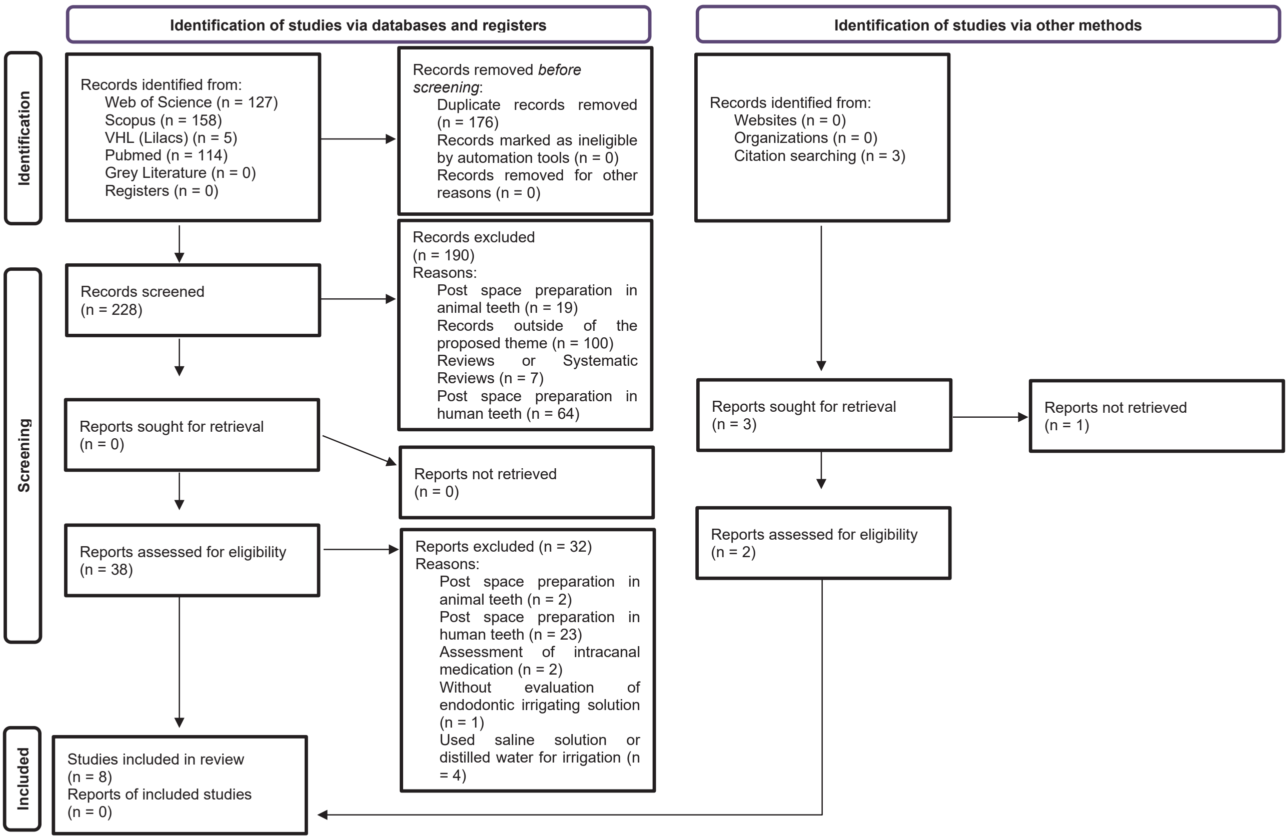

Figure 1 - Flowchart PRISMA 2020.

of the included studies were also searched to identify other studies that might have been missed in the initial electronic search. MeSH terms "Sodium Hypochlorite", "Chlorhexidine", "Root Canal Irrigants", "Chelating Agents", "Edetic Acid", "Photochemotherapy", "Citric Acid", "Hydrogen Peroxide", "Saline Solution", "Boric Acids", "Post and Core Technique", "Adhesive", "Shear Strength" and "Dentin", and DeCS terms "Sodium Hypochlorite", "Chlorhexidine", "Root Canal Irrigants", "Edetic Acid", "Photochemotherapy", "Citric Acid", "Distilled Water", "Hydrogen Peroxide", "Saline Solution", "Post and Core Technique", "Adhesive", "Shear Strength" and "Dentin" were used. MeSH synonyms, related terms, and free terms were also included. The Boolean operators "AND" and "OR" were applied to combine these terms, and the combination of these search descriptors is shown in Table I.

Eligibility criteria

The eligibility criteria were based on the PICO strategy, as follows:

Population (P): Permanent human teeth or animal teeth

Intervention (I): Alternative irrigation solutions used during root canal instrumentation

Comparison (C): Irrigation with sodium hypochlorite in its various concentrations

Outcome (O): To analyze the bond strength of glass fiber posts.

Study design (S): Laboratory study.

Literature reviews, systematic reviews, opinion articles, letters to the editor, guidelines, case reports, studies that evaluated the preparation of the root space for glass fiber posts and intracanal medication in both human and animal teeth, studies that did not compare bond strength or endodontic irrigating solutions, and articles outside the proposed theme were excluded.

Selection of the studies

The results of the electronic search were managed using Mendeley software. Two authors (I.G.R. and L.S.G.) independently selected the retrieved studies, examined the titles and abstracts based on the eligibility criteria using the PICO strategy. The selected articles were read in full and only potential studies were

Table I - Electronic database used and search strategy

Database	Search Strategy
PubMed	**#1**(Sodium Hypochlorite[MeSH Terms]) OR (Chlorhexidine[MeSH Terms])) OR (Root Canal Irrigants[MeSH Terms])) OR (Chelating Agents[MeSH Terms])) OR (Edetic Acid[MeSH Terms])) OR (Photochemotherapy[MeSH Terms])) OR (Citric Acid[MeSH Terms])) OR (Hydrogen Peroxide[MeSH Terms])) OR (Saline Solution[MeSH Terms])) OR (Boric Acids[MeSH Terms])) OR (Sodium Hypochlorite[Title/Abstract])) OR (EDTA[Title/Abstract])) OR (Edetic Acid[Title/Abstract])) OR (PDTa[Title/Abstract])) OR (Photodynamic Therapy[Title/Abstract])) OR (Photochemotherapy[Title/Abstract])) OR (Antimicrobial Solutions[Title/Abstract])) OR (Chlorhexidine[Title/Abstract])) OR (Irrigation Solutions[Title/Abstract])) OR (Root Canal Irrigants[Title/Abstract])) OR (Chelating Agents[Title/Abstract])) OR (Citric Acid[Title/Abstract])) OR (Distilled Water[Title/Abstract])) OR (Hydrogen Peroxide[Title/Abstract])) OR (Urea Peroxide[Title/Abstract])) OR (Saline Solution[Title/Abstract])) OR (Calcium Hydroxide Solution[Title/Abstract])) OR (Boric Acid[Title/Abstract])) OR (Polyacrylic Acid[Title/Abstract])) OR (Silver Nanoparticle (Ag-NP) dispersion[Title/Abstract]) **#2**(Post and Core Technique[MeSH Terms]) OR (Glass Fiber Posts[Title/Abstract])) OR (Fiber Posts[Title/Abstract])) OR (Dental Posts[Title/Abstract])) OR (Root Retainer[Title/Abstract])) OR (Post and Core Technique[Title/Abstract]) **#3**(Adhesive[MeSH Terms]) OR (Shear Strength[MeSH Terms])) OR (Adhesion[Title/Abstract])) OR (Shear Strength[Title/Abstract])) OR (Push-out Strength[Title/Abstract])) OR (Adhesive[Title/Abstract]) **#4**(Dentin[MeSH Terms]) OR (Dentine[Title/Abstract])) OR (Root Dentin[Title/Abstract])) OR (Radicular Dentin[Title/Abstract])) OR (Root Canal Dentin[Title/Abstract])) OR (Dentin[Title/Abstract]) **#1 and #2 and #3 and #4**
Scopus	**#1**(TITLE-ABS-KEY ("Sodium Hypochlorite") OR TITLE-ABS-KEY (edta) OR TITLE-ABS-KEY ("Edetic Acid") OR TITLE-ABS-KEY (pdta) OR TITLE-ABS-KEY ("Photodynamic Therapy") OR TITLE-ABS-KEY (photochemotherapy) OR TITLE-ABS-KEY ("Antimicrobial Solutions") OR TITLE-ABS-KEY (chlorhexidine) OR TITLE-ABS-KEY ("Irrigation Solutions") OR TITLE-ABS-KEY ("Root Canal Irrigants") OR TITLE-ABS-KEY ("Chelating Agents") OR TITLE-ABS-KEY ("Citric Acid") OR TITLE-ABS-KEY ("Distilled Water") OR TITLE-ABS-KEY ("Hydrogen Peroxide") OR TITLE-ABS-KEY ("Urea Peroxide") OR TITLE-ABS-KEY ("Saline Solution") OR TITLE-ABS-KEY ("Calcium Hydroxide Solution") OR TITLE-ABS-KEY ("Boric Acid") OR TITLE-ABS-KEY ("Polyacrylic Acid") OR TITLE-ABS-KEY ("Silver Nanoparticle (Ag-NP) dispersion")) **#2**(TITLE-ABS-KEY ("Glass Fiber Posts") OR TITLE-ABS-KEY ("Fiber Posts") OR TITLE-ABS-KEY ("Dental Posts") OR TITLE-ABS-KEY ("Root Retainer") OR TITLE-ABS-KEY ("Post and Core Technique")) **#3**(TITLE-ABS-KEY (adhesion) OR TITLE-ABS-KEY ("Shear Strength") OR TITLE-ABS-KEY ("Push-out Strength") OR TITLE-ABS-KEY (adhesive)) **#4**(TITLE-ABS-KEY (dentine) OR TITLE-ABS-KEY ("Root Dentin") OR TITLE-ABS-KEY ("Radicular Dentin") OR TITLE-ABS-KEY ("Root Canal Dentin") OR TITLE-ABS-KEY (dentin)) **#1 and #2 and #3 and #4**
Web of Science	**#1TOPIC:**("Sodium Hypochlorite") *OR* **TOPIC:** (EDTA) *OR* **TOPIC:** ("Edetic Acid") *OR* **TOPIC:** (PDTa) *OR* **TOPIC:** ("Photodynamic Therapy") *OR* **TOPIC:** (Photochemotherapy) *OR* **TOPIC:** ("Antimicrobial Solutions") *OR* **TOPIC:** (Chlorhexidine) *OR* **TOPIC:** ("Irrigation Solutions") *OR* **TOPIC:** ("Root Canal Irrigants") *OR* **TOPIC:** ("Chelating Agents") *OR* **TOPIC:** ("Citric Acid") *OR* **TOPIC:** ("Distilled Water") *OR* **TOPIC:** ("Hydrogen Peroxide") *OR* **TOPIC:** ("Urea Peroxide") *OR* **TOPIC:** ("Saline Solution") *OR* **TOPIC:** ("Calcium Hydroxide Solution") *OR* **TOPIC:** ("Boric Acid") *OR* **TOPIC:** ("Polyacrylic Acid") *OR* **TOPIC:** ("Silver Nanoparticle (Ag-NP) dispersion") *Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan= All years* **#2TOPIC:**("Glass Fiber Posts") *OR* **TOPIC:** ("Fiber Posts") *OR* **TOPIC:** ("Dental Posts") *OR* **TOPIC:** ("Root Retainer") *OR* **TOPIC:** ("Post and Core Technique") *Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan= All years* **#3TOPIC:**(Adhesion) *OR* **TOPIC:** ("Shear Strength") *OR* **TOPIC:** ("Push-out Strength") *OR* **TOPIC:** (Adhesive) *Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan= All years* **#4TOPIC:**(Dentine) *OR* **TOPIC:** ("Root Dentin") *OR* **TOPIC:** ("Radicular Dentin") *OR* **TOPIC:** ("Root Canal Dentin") *OR* **TOPIC:** (Dentin) *Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI Timespan= All years* **#1 and #2 and #3 and #4**
VHL (LILACS)	(tw:(sodium hypochlorite OR chlorhexidine OR edetic acid OR photochemotherapy OR citric acid OR distilled water OR hydrogen peroxide OR saline solution OR root canal irrigants)) AND (tw:(post and core technique)) AND (tw:(adhesive OR shear strength)) AND (tw:(dentin))) AND (db:("LILACS"))
Grey Literature	Root Canal Irrigants AND Glass Fiber Posts AND Adhesion AND Root Dentin

included. A kappa match of 0.90 was calculated to ensure reliability between the authors during the selection. In case of disagreement regarding the inclusion of the study, a third author (L.S.A.) was contacted. Duplicate studies were removed from the database and considered only once.

Data extraction

Two independent authors (I.G.R. and L.S.G.) collected the data from the included studies. The authors of these primary studies were contacted if data were absent. Data from the included studies were compiled and organized according to the following parameters: the first author of the article, year of publication, teeth origin, n/group of teeth, root canal treatment (irrigation solution groups during treatment (n), final irrigation solutions (n), instrumentation, endodontic sealer), preparation of glass fiber posts (drills used, glass fiber posts cleaning, adhesive system/sealer), bond strength test, bond strength values (mean/SD), and results (sodium hypochlorite × other irrigation solutions and different concentrations of sodium hypochlorite).

Quality assessment

The risk of bias was evaluated by two independent reviewers (I.G.R. and L.S.G.) using an instrument adapted for laboratory studies [27-29], and assessed according to the articles' description of the following parameters: randomization of teeth, use of materials according to the manufacturer's instructions, use of teeth with similar dimensions, root canal treatment performed by a single operator, standardization of procedures, description of sample size calculation, and blinding of the operator of the testing machine.

If the authors reported the parameter, the article had "Yes" on that specific parameter; if the information could not be found, the article received "No". Articles that reported one to three "Yes" items were classified as high risk of bias, four or five "Yes" items as medium risk of bias, and six or seven "Yes" items as low risk of bias.

Publication bias

Publication bias was verified in primary studies when analyzing the greater probability of these studies being published because of their positive results, sample size and/or financed by companies.

RESULTS

Search strategy and selection of the studies

A total of 404 potentially relevant articles were identified from PubMed (114), Scopus (158), Web of Science (127), and LILACS (5) databases. The grey literature was consulted through OpenGrey, and no articles were found. After removing duplicates, 228 articles were examined for titles and abstracts. One hundred and ninety studies were excluded because they did not meet the eligibility criteria, and 38 articles were approved for reading the entire text. After applying the eligibility criteria after full reading, 32 studies were excluded and a total of 6 studies were included in this review. Three additional articles were identified by a manual search. An article found in the manual search was not found in the databases, and the authors and co-authors were contacted to obtain the article, but without success, making it impossible to select this article for the study. Therefore, eight articles were included in this study. Figure 1 summarizes the selection process.

Parameters of the included studies

Four articles [17,18,21,30] used animal teeth (bovine). Of these, two did not specify which type of tooth they used [21,30] and two used bovine incisors [17,18]. The remaining four articles [20,22,24,31] used human teeth. Two studies used single-rooted human teeth [22,24], one study used human premolars [20], and one study used human c-shaped canal molars [31] (Table II).

Sodium hypochlorite was used as irrigation solution during root canal treatment in all studies [17,18,20-22,24,30,31], and this substance is used in various concentrations, from 1% to 5.25%. Another widely used substance is chlorhexidine, at different concentrations of 0.2% [22] and 2% [17,18,21,24,30,31] (Table II).

Regarding the final irrigant used in root canal treatment, most of the studies used ethylenediaminetetraacetic acid (EDTA). Two studies used EDTA with ultrasonic vibration [18,21], and two articles used only ETDA [17,24]. Two articles used distilled water for final irrigation [20,30] (Table II).

Most studies used manual instrumentation [18,20,21,31]. Two studies performed rotary instrumentation [22,24], and only one study divided its sample and performed half manual instrumentation and the other half rotary instrumentation [17]. Finally, a study was conducted on the instrumentation of the root canal using a high-precision electric drill with

Table II - Characteristics of included studies (n=8)

Author (Year)	Teeth origin	n/Group of teeth	Root canal treatment: Irrigation solutions groups during treatment (n)	Root canal treatment: Final irrigation solutions (n)	Root canal treatment: Instrumentation	Root canal treatment: Endodontic sealer	Preparation of glass fiber posts: Drills used	Preparation of glass fiber posts: Glass fiber posts cleaning	Preparation of glass fiber posts: Adhesive system/Sealer	Bond strenght test
Pelegrine et al., 2010 [21]	Bovine	50/MD	**G1:** 0.9% NaCl (n=10) **G2:** 1.0% NaOCl (n=10) **G3:** 2.5% NaOCl (n=10) **G4:** 5.25% NaOCl (n=10) **G5:** 2% CHX-G + 0.9% NaCl (n=10)	EDTA with ultrasonic vibration + Same irrigant solutions	Modified step-back technique with manual K-type files and flaring was completed using Gates-Glidden #6 and #5.	AH Plus	#5 Largo	70% alcohol and 37% phosphoric acid	Self-etch 2-step adhesive system Clearfil SE Bond + RelyX ARC resin cement	Tensile strength test
Grassi et al., 2012 [22]	Human	40/Single-rooted	**G1**: 0.2% CHX + PCS (n=10) **G2:** 5% NaOCl + PCS (n=10) **G3:** 5% NaOCl + AX (n=10) **G4:** 0.2% CHX + AX (n=10)	MD	Profile instrument to master apical rotary size 35–45.	**G1**: PCS **G2:** PCS **G3:** AX **G4:** AX	Gates-Glidden	According to the manufacturer	Dual adhesive Surgi Primebond Base + Surgi Primebond Activator/Surgi Dual Flò Core cement	Micro-push-out test
Santana et al., 2015 [17]	Bovine	120/Incisors	**G1:** 1% NaOCl + SS + Immediate (n=10) **G2:** 2% CHX + SS + Immediate (n=10) **G3:** 1.2% O3 + SS + Immediate (n=10) **G4:** 1% NaOCl + NiTi + Immediate (n=10) **G5:** 2% CHX + NiTi + Immediate (n=10) **G6:** 1.2% O3 + NiTi + Immediate (n=10) **G7:** 1% NaOCl + SS + Aged (n=10) **G8:** 2% CHX + SS + Aged (n=10) **G9:** 1.2% O3 + SS + Aged (n=10) **G10:** 1% NaOCl + NiTi + Aged (n=10) **G11:** 2% CHX + NiTi + Aged (n=10) **G12:** 1.2% O3 + NiTi + Aged (n=10)	EDTA + Same irrigant solutions	**SS:** # 1,2 Gates-Glidden, # 2 Largo and stainless steel instruments up to #45 K-file. **NiTi:** # 1,2 Gates-Glidden and K3 nickel-titanium rotary instruments.	Root canals were not filled to avoid interference.	#3 to #5 Largo	70% alcohol	Self-adhesive resin cement - RelyX U100	Push-out test with or without artificial accelerated aging

MD: missing data; NaCl: sodium chloride; NaOCl: sodium hypochlorite; CHX: chlorhexidine; CHX-G: chlorhexidine gel; O3: ozonated water; CaOCl: calcium hypochlorite; NS: normal saline; EDTA: ethylenediaminetetraacetic acid; DS: distilled water; MB: methylene blue; aPDT: antimicrobial photodynamic therapy; Er,Cr:YSGG: erbium chromium yttrium scandium gallium garnet; PCS: pulp canal sealer™ - cement based on zinc oxide and eugenol; AX: apexit- cement based on calcium hydroxide; SS: root canal preparation with stainless steel instruments; NiTi: root canal preparation with K3® nickel titanium rotary instruments; SMP: scotchbond multi-purpose; EDP: ED primer; PaF: panavia; AH26: a resin-based sealer silver-free Dentsply ®.

Table II - Continued...

Author (Year)	Teeth origin	n/Group of teeth	Root canal treatment				Preparation of glass fiber posts			Bond strenght test
			Irrigation solutions groups during treatment (n)	Final irrigation solutions (n)	Instrumentation	Endodontic sealer	Drills used	Glass fiber posts cleaning	Adhesive system/Sealer	
Bueno et al., 2016 [18]	Bovine	96/Incisors	**G1:** NS + SMP + RelyX (n=8) **G2:** 2.5% NaOCl + SMP + RelyX (n=8) **G3:** 5.25% NaOCl + SMP + RelyX (n=8) **G4:** 2% CHX + SMP + RelyX (n=8) **G5:** NS + EDP + PaF (n=8) **G6:** 2.5% NaOCl + EDP + PaF (n=8) **G7:** 5.25% NaOCl + EDP + PaF (n=8) **G8:** 2% CHX + EDP + PaF (n=8) **G9:** NS + U100 (n=8) **G10:** 2.5% NaOCl + U100 (n=8) **G11:** 5.25% NaOCl + U100 (n=8) **G12:** 2% CHX + U100 (n=8)	EDTA with ultrasonic vibration + Same irrigant solutions	Modified step-back technique with manual K-type files.	AH Plus	#5 Largo	70% alcohol and 37% phosphoric Acid	**G1-4:** SMP + RelyX **G5-8:** EDP + PaF **G9-12:** U100	Push-out shear test
Kaif and Bis, 2016 [24]	Human	30/Single-rooted	**G1:** 5.25% NaOCl (n=10) **G2:** 2% CHX (n=10) **G3:** DS (n=10)	EDTA	Protaper nickel-titanium rotary instrumentation: S1, S2, and F3.	AH Pus	#3 Gates-Glidden #5 Peeso reamer	70% Isopropyl alcohol	Adper Single Bond 2 + RelyX ARC	Push-out test
Khoroushi et al., 2019 [20]	Human	40/Premolars	**G1**: 0.9% NS (n=8) **G2:** 2.5% NaOCl (n=8) **G3:** 5.25% NaOCl (n=8) **G4:** 2,5% CaOCl (n=8) **G5:** 5% CaOCl (n=8)	DS	Conventional step-back technique with #35 K-file and #2, #3 Gates-Glidden.	AH26	#2 and #3 Gates-Glidden drills	Alcohol	BisCem self-adhesive cement	Push-out test
Hashem et al., 2021 [31]	Human	60/C-shaped Canal Molars	**G1:** aPDT 2% MB + diode laser (n=15) **G2:** Er,Cr:YSGG laser (n=15) **G3:** 2% CHX (n=15) **G4:** 1.5% NaOCl (n=15)	MD	Step-back technique using K-files and #2, #3 and #4 Gates Glidden Burs.	AH26	Peeso reamers	70% alcohol	MD	Push-out
Macedo et al., 2021 [30]	Bovine	77/MD	**G1:** 2.5% NaOCl (n=11) **G2:** DS (n=11) **G3:** 2% CHX (n=11) **G4:** O3 (n=11) **G5:** 2.5% NaOCl + DS (n=11) **G6:** 2.5% NaOCl + 2% CHX (n=11) **G7:** 2.5% NaOCl + O3 (n=11)	DS	The root canals were prepared by using a high-precision electric drill with torque control and a 2mm steel bit	Sealer 26	Gates-Glidden	MD	Self-adhesive cement RelyX U200	Push-out

MD: missing data; NaCl: sodium chloride; NaOCl: sodium hypochlorite; CHX: chlorhexidine; CHX-G: chlorhexidine gel; O3: ozonated water; CaOCl: calcium hypochlorite; NS: normal saline; EDTA: ethylenediaminetetraacetic acid; DS: distilled water; MB: methylene blue; aPDT: antimicrobial photodynamic therapy; Er,Cr:YSGG: erbium chromium yttrium scandium gallium garnet; PCS: pulp canal sealer™ - cement based on zinc oxide and eugenol; AX: apexit- cement based on calcium hydroxide; SS: root canal preparation with stainless steel instruments; NiTi: root canal preparation with K3® nickel titanium rotary instruments; SMP: scotchbond multi-purpose; EDP: ED primer; PaF: panavia; AH26: a resin-based sealer silver-free Dentsply ®.

torque control [30]. Most studies used AH Plus endodontic sealer to perform canal filling together with gutta percha [18,21,24] (Table II).

Gates Glidden drills were used in the preparation of glass fiber posts in four studies [20,22,24,30]. However, one of these studies associated Gates Glidden with the Peeso Reamer [24], and one study used only the Peeso Reamer [31]. Largo drill was used in three studies [17,18,21] (Table II).

The majority of the studies used alcohol to clean glass fiber post [17,18,20,21,24,31], and of these studies, two had associated the use of alcohol with phosphoric acid [18,21] (Table II).

With regard to the adhesive system used for the cementation of glass fiber posts, two studies used a two-step etch-rinse system [22,24], one study used a two-step self-etching adhesive system [21], and three studies used self-etching and self-adhesive cements [17,20,30]. One study used more than one adhesive system including a three-step etch-rinse system, a two-step self-etching system and self-etching and self-adhesive cement [18] (Table II).

Regarding the bond strength tests of the glass fiber post to the root dentin, almost all studies have perfomed push-out tests [17,18,20,24,30,31]. Of these, one study perfomed the push-out test with and without artificial accelerated aging [17], while another study performed, in addition to the push-out test, the shear bond strength test [18]. Only one study performed the micro-push-out test [22], and one study performed the tensile strength test [21] (Table II).

Four studies showed that the endodontic substances used during treatment did not influence the adhesion of the glass fiber post to root dentin [18,21,22,24]. However, Santana et al. [17] reported an increase in bond strength when using sodium hypochlorite, compared with ozonized water. Conversely, a study by Macedo et al. [30] showed that 2.5% sodium hypochlorite with ozonized water showed better results in terms of its effect on bond strength. Another study showed that specimens treated with photodynamic therapy had the highest bond strength with the fewest failures [31]. Although the study by Khoroushi et al. [20] did not show a statistically significant difference between the other solutions, showed that the highest bond strength was observed in the 5% calcium hypochlorite group (Table III).

In relation to different concentrations of sodium hypochlorite, two studies showed no statistical differences in bond strength [20,21]. One study reported that sodium hypochlorite in its most concentrated form (5.25%) had a significant adverse impact on bond strength, when combined with RelyX U100 resin cement [18] (Table III).

Quality assessment

Four articles [20,24,30,31] were classified as high risk of bias and the other four articles [17,18,21,22] as medium risk of bias, as shown in Table IV. None of the studies succeeded in blinding of the operator of the testing machine, nor performed the sample calculation, which is considered the greatest difficulty of the articles in general.

Publication bias

Although the laboratory studies included a small sample and no study performed an adequate sample size calculation, there was less publication bias due to the publication of both positive and negative results for the questions evaluated. In addition, these studies were not funded by companies.

DISCUSSION

The teeth submitted to root canal treatment, in the great majority, have a great loss of dental structure, requiring glass fiber posts to retain a future restoration [11]. There is great clinical concern regarding the influence of endodontic irrigation solutions on the bond strength of glass fiber posts to root dentin. In this review, only eight studies [17,18,20-22,24,30,31] were found that answered the question raised. The articles have inconsistencies and different estimates among themselves; in addition, few studies have evaluated the different concentrations of sodium hypochlorite, which is the most used endodontic irrigation substance. Therefore, conclusive data on this issue are lacking, with good studies outlined and without methodological bias.

The evaluation of methodological quality was perfomed with high rigor using an adapted tool [27-29] for laboratory studies. The great difficulty of the articles was in performing blinding of the testing machine operator, root canal

Table III - Characteristics of bond strength tests from the included studies (n=8)

Author (Year)	Groups (n)	Bond strenght test	Bond strenght values (Mean/SD)	Results: NaOCl x Other irrigation solutions	Results: Different concentrations of NaOCl
Pelegrine et al., 2010 [21]	**G1:** 0.9% NaCl (n=10)	**Tensile strength test:** an acrylic resin cylinder fitted on top with a metallic loop was made over the coronal portion of the post. After the resin was polymerized, the test specimen was placed in a Universal Testing Machine, and an axial tensile load was applied at 0.5 mm/min until failure.	**G1**: 24.661±9.776	NaOCl did not reduce adhesion compared with the groups irrigated with chlorhexidine.	Different concentrations of NaOCl tested did not influence the tensile bond strength of the adhesive system used in this study to cement glass fiber posts in root dentin.
	G2: 1.0% NaOCl (n=10)		**G2**: 28.537±11.704		
	G3: 2.5% NaOCl (n=10)		**G3:** 27.537±9.681		
	G4: 5.25% NaOCl (n=10)		**G4:** 25.572±8.801		
	G5: 2% CHX-G + 0.9% NaCl (n=10)		**G5:** 28.831±9.389		
Grassi et al., 2012 [22]	**G1**: 0.2% CHX + PCS (n=10)	**Micro-push-out test:** it was performed on a 3343 Instron Universal Testing Machine with a load cell of 500 N. The crosshead speed was set equal to 1 mm/min.	**G1**: 15.1±4.6	The interfacial shear strength values do not seem to depend on the group (irrigant/endodontic sealer) in which the samples were classified, and no statistically significant differences were observed.	--------
	G2: 5% NaOCl + PCS (n=10)		**G2:** 14.1±4.4		
	G3: 5% NaOCl + AX (n=10)		**G3:** 14.0±6.0		
	G4: 0.2% CHX + AX (n=10)		**G4:** 16.8±5.4		
Santana et al., 2015 [17]	**G1:** 1% NaOCl + SS + Immediate (n=10)	**Push-out test:** in immediate groups, slices were submitted immediately to a push-out test; while in aged groups, slices were stored in distilled water at 37°C for 2 months (artificial accelerated aging) prior to testing. The push-out test was performed in a Testing Machine by applying a compressive load at 0.5 mm/min from the apical to coronal direction until failure. The bond strength was calculated in MPa by dividing the load at failure (N) by the area of the bonded interface.	**G1:** Cervical 12.9±2.4, Middle 10.3±4.0, Apical 7.1±3.8	NaOCl resulted in higher bond strength than with O3. CHX resulted on intermediate values that were statistically similar to values obtained in groups irrigated with O3. Regardless of irrigant solutions, cervical third had higher bond strength values than apical third. A significant bond strength increases after artificial accelerated aging, except for middle and apical thirds of SS-O3 and apical of NiTi-O3, which was similar.	--------
	G2: 2% CHX + SS + Immediate (n=10)		**G2:** Cervical 11.4±3.3, Middle 9.8±3.9, Apical 6.7±3.9		
	G3: 1.2% O3 + SS + Immediate (n=10)		**G3:** Cervical 8.7±6.8, Middle 6.2±5.0, Apical 3.5±2.9		
	G4: 1% NaOCl + NiTi + Immediate (n=10)		**G4:** Cervical 13.5±2.1, Middle 11.4±3.3, Apical 9.3±4.8		
	G5: 2% CHX + NiTi + Immediate (n=10)		**G5:** Cervical 11.5±3.8, Middle 10.0±4.9, Apical 7.1±5.6		
	G6: 1.2% O3 + NiTi + Immediate (n=10)		**G6:** Cervical 9.5±3.4, Middle 7.4±1.6, Apical 6.8±1.4		
	G7: 1% NaOCl + SS + Aged (n=10)		**G7:** Cervical 24.1±5.8, Middle 20.3±7.7, Apical 15.5±8.6		
	G8: 2% CHX + SS + Aged (n=10)		**G8:** Cervical 18.8±4.3, Middle 16.2±4.0, Apical 13.3±7.2		
	G9: 1.2% O3 + SS + Aged (n=10)		**G9:** Cervical 17.4±4.9, Middle 9.9±4.0, Apical 6.4±3.4		
	G10: 1% NaOCl + NiTi + Aged (n=10)		**G10:** Cervical 25.1±6.4, Middle 22.6±6.1, Apical 21.6±6.3		
	G11: 2% CHX + NiTi + Aged (n=10)		**G11:** Cervical 21.4±3.4, Middle 20.8±6.3, Apical 18.4±7.7		
	G12: 1.2% O3 + NiTi + Aged (n=10)		**G12:** Cervical 17.4±4.9, Middle 11.0±5.3, Apical 7.1±3.8		

NaCl: sodium chloride; NaOCl: sodium hypochlorite; CHX: chlorhexidine; CHX-G: chlorhexidine gel; O3: ozonated water; CaOCl: calcium hypochlorite; NS: normal saline; DS: distilled water; MB: methylene blue; aPDT: antimicrobial photodynamic therapy; Er,Cr:YSGG: erbium chromium yttrium scandium gallium garnet; PCS: pulp canal sealer™ - cement based on zinc oxide and eugenol; AX: apexit- cement based on calcium hydroxide; SS: root canal preparation with stainless steel instruments; NiTi: root canal preparation with K3® nickel titanium rotary instruments; SMP: scotchbond multi-purpose; EDP: ED primer; PaF: panavia; MPa: megapascals; N: Newtons.

Table III - Continued...

Author (Year)	Groups (n)	Bond strenght test	Bond strenght values (Mean/SD)	Results	
				NaOCl x Other irrigation solutions	Different concentrations of NaOCl
Bueno et al., 2016 [18]	**G1:** NS + SMP + RelyX (n=8) **G2:** 2.5% NaOCl + SMP + RelyX (n=8) **G3:** 5.25% NaOCl + SMP + RelyX (n=8) **G4:** 2% CHX + SMP + RelyX (n=8) **G5:** NS + EDP + PaF (n=8) **G6:** 2.5% NaOCl + EDP + PaF (n=8) **G7:** 5.25% NaOCl + EDP + PaF (n=8) **G8:** 2% CHX + EDP + PaF (n=8) **G9:** NS + U100 (n=8) **G10:** 2.5% NaOCl + U100 (n=8) **G11:** 5.25% NaOCl + U100 (n=8) **G12:** 2% CHX + U100 (n=8)	**Push-out shear test:** the specimens obtained were identified and kept in distilled water for 24 hours at 37°C in containers that did not allow the passage of light. An axial compressive load of 100 N was applied to the apical surface of the post section at a speed of 1.0 mm/min until the cross section of the post became separated from its respective root section. The kilogram-force values applied until separation were divided by the root canal area to convert results to MPa.	**G1:** 9.47±9.86 **G2:** 12.61±7.85 **G3:** 13.92±4.77 **G4:** 12.19±7.87 **G5:** 10.87±5.57 **G6:** 12.09±5.02 **G7:** 9.47±4.46 **G8:** 11.11±5.51 **G9**: 14.00±6.82 **G10:** 15.29±6.39 **G11:** 8.82±4.12 **G12**: 13.36±8.34	There was no statistically significant reduction in bond strength when comparing the irrigants.	NaOCl in its more concentrated form (5.25%) had a significant adverse impact on the bond of fiber posts luted with RelyX U100 self-adhesive resin cement to dentin.
Kaif and Bis, 2016 [24]	**G1:** 5.25% NaOCl (n=10) **G2:** 2% CHX (n=10) **G3:** DS (n=10)	**Push-out test:** the test specimen slices were fixed in the fitting device fitted to the Universal Testing Machine. The 0.8-mm diameter tip was placed over the smallest base of the test specimen and a compression force was applied in an apical-coronal direction at a crosshead speed of 0.5 mm/minute until the post piece was dislocated. The peak value of the load required for dislocating the post from the specimen was recorded in Newtons.	**G1:** 38.29±21.54 **G2:** 38.95±12.16 **G3**: 39.60±14.76	No significant differences in bond strength were found between the groups.	--------
Khoroushi et al., 2019 [20]	**G1**: 0.9% NS (n=8) **G2:** 2.5% NaOCl (n=8) **G3:** 5.25% NaOCl (n=8) **G4:** 2,5% CaOCl (n=8) **G5:** 5% CaOCl (n=8)	**Push-out test:** it was carried out for each section at a crosshead speed of 0.5mm/minute using a Universal Testing Machine. The maximum force at the point where the post was dislodged from the root section was considered as the bond failure point and was recorded in Newton. Then, the push-out bond strengths were calculated in MPa.	**G1:** 7.28±2.66 **G2:** 8.15± 2.51 **G3:** 8.38±3.76 **G4:** 8.9±3.13 **G5:** 11.84± 2.04	The highest bond strength belonged to the 5% calcium hypochlorite group.	There was no statistical difference.

NaCl: sodium chloride; NaOCl: sodium hypochlorite; CHX: chlorhexidine; CHX-G: chlorhexidine gel; O3: ozonated water; CaOCl: calcium hypochlorite; NS: normal saline; DS: distilled water; MB: methylene blue; aPDT: antimicrobial photodynamic therapy; Er,Cr:YSGG: erbium chromium yttrium scandium gallium garnet; PCS: pulp canal sealer™ - cement based on zinc oxide and eugenol; AX: apexit- cement based on calcium hydroxide; SS: root canal preparation with stainless steel instruments; NiTi: root canal preparation with K3® nickel titanium rotary instruments; SMP: scotchbond multi-purpose; EDP: ED primer; PaF: panavia; MPa: megapascals; N: Newtons.

Table III - Continued...

Author (Year)	Groups (n)	Bond strenght test	Bond strenght values (Mean/SD)	Results	
				NaOCl x Other irrigation solutions	Different concentrations of NaOCl
Hashem et al., 2021 [31]	**G1:** aPDT 2% MB + diode laser (n=15)	**Push-out test:** The roots submitted to post cementation were sectioned along the shaft using a low speed diamond saw. The slices obtained from the specimens were individually fixed in the Universal testing machine. The push-out was calculated by dividing the maximum failure load into Newtons to surface area of connecting pin segments in mm^2.	**G1**: 8.56±2.12	The specimens treated with aPDT showed the highest push out bond strength with least number of failures in c-shaped mandibular root canals.	--------
	G2: Er,Cr:YSGG laser (n=15)		**G2**: 7.90±1.56		
	G3: 2% CHX (n=15)		**G3:** 7.34±1.23		
	G4: 1.5% NaOCl (n=15)		**G4:** 6.92±2.21		
Macedo et al., 2021 [30]	**G1:** 2.5% NaOCl (n=11)	**Push-out test:** The roots were fixed on a metallic base in the ISOMET 1000 stake machine and sectioned perpendicularly along the root axis. Three discs were sectioned for each third (cervical, middle and apical). The specimens	**G1:** Cervical 10.71±1.74, Medium 9.47±2.29, Apical 6.3±1.98	The sodium hypochlorite solution showed a statistically similar behaviour to the group of sodium hypochlorite solution + ozonated water, the latter being the best results in terms of its effect on the bond strength. Regardless of root depth, the sodium hypochlorite + chlorhexidine solution group showed the worst binding strength.	--------
	G2: DS (n=11)	were stored under relative humidity at 37°C for 7 days. And for the push-out test, a metal cylinder was used to induce a charge at the center part of the post-cement set. The test was carried out in a universal testing machine.	**G2:** Cervical 8.05±, Medium 5.21±1.20, Apical 3.18±1.36		
	G3: 2% CHX (n=11)		**G3:** Cervical 8.09±1.21, Medium 4.88±1.12, Apical 3.82±1.29		
	G4: O3 (n=11)		**G4:** Cervical 10.91±2.03, Medium 8.66±1.52, Apical 6.41±2.11		
	G5: 2.5% NaOCl + DS (n=11)		**G5:** Cervical 8.44±2.17, Medium 6.57±1.48, Apical 5.69±1.36		
	G6: 2.5% NaOCl + 2% CHX (n=11)		**G6:** Cervical 6.93±1.13, Medium 5.58±1.16, Apical 3.31±0.96		
	G7: 2.5% NaOCl + O3 (n=11)		**G7:** Cervical 9.27±1.24, Medium 7.38±1.12, Apical 5.6±1.24		

NaCl: sodium chloride; NaOCl: sodium hypochlorite; CHX: chlorhexidine; CHX-G: chlorhexidine gel; O3: ozonated water; CaOCl: calcium hypochlorite; NS: normal saline; DS: distilled water; MB: methylene blue; aPDT: antimicrobial photodynamic therapy; Er,Cr:YSGG: erbium chromium yttrium scandium gallium garnet; PCS: pulp canal sealer™ - cement based on zinc oxide and eugenol; AX: apexit- cement based on calcium hydroxide; SS: root canal preparation with stainless steel instruments; NiTi: root canal preparation with K3® nickel titanium rotary instruments; SMP: scotchbond multi-purpose; EDP: ED primer; PaF: panavia; MPa: megapascals; N: Newtons.

Table IV - Quality assessment methodological of included studies (n=8)

	Teeth randomization	Materials used according to the manufacturer's instructions	Teeth with similar dimensions	Root canal treatment performed by a single operator	Standardization of procedures	Sample size calculation	Blinding of the operator of the testing machine	Risk of bias
Pelegrine et al., 2010 [21]	Yes	Yes	Yes	Yes	Yes	No	No	Medium
Grassi et al., 2012 [22]	Yes	Yes	No	Yes	Yes	No	No	Medium
Santana et al., 2015 [17]	Yes	Yes	Yes	No	Yes	No	No	Medium
Bueno et al., 2016 [18]	Yes	Yes	Yes	Yes	Yes	No	No	Medium
Kaif and Bis, 2016 [24]	No	Yes	No	No	Yes	No	No	High
Khoroushi et al., 2019 [20]	Yes	No	Yes	No	Yes	No	No	High
Hashem et al., 2021 [31]	Yes	Yes	No	No	Yes	No	No	High
Macedo et al., 2021 [30]	No	Yes	Yes	No	Yes	No	No	High

treatment by a single operator, or calculation of the sample in the research. These requirements are extremely important and must be met to reduce both imprecision and inconsistencies in the scientific literature.

Human teeth are more reliable in terms of bond strength, because they have the same mineral composition that we deal with in clinical management. However, some studies [17,18,21,30] have used bovine teeth. Bovine teeth have similarities in morphology to human teeth, less variability of tissue permeability and internal anatomy with the smallest variation and have been used as a substitute for human teeth in bond strength tests [4,32,33].

Chemical solutions used for disinfection, cleaning, and completing of the mechanical instrumentation process during root canal treatment can cause physical and chemical changes, such as decreased microhardness and increased permeability of the root canal dentin [34,35].

Sodium hypochlorite is the chemical substance most commonly used in root canal treatment, because of its antimicrobial power, as well as its unique ability to dissolve remnants of necrotic tissues [2]. However, it is noteworthy that sodium hypochlorite decomposes into sodium chloride and oxygen, and when there is oxygen in the surface layer, there is an inhibition of the binding of resin cement and dentin [36,37], which interferes with the penetration of adhesive in the dentinal tubules [38], impairing the bond strength. On the other hand, chlorhexidine is a potent antiseptic widely used in dentistry, and has also been used as an endodontic irrigant solution at concentrations of 0.2% to 2%. It inhibits the growth of bacteria commonly found in endodontic infections [39], has a residual effect [40], and has low cytotoxicity [41]. It has a harmless effect on the microhardness and dentin roughness of the root canal [38], which can result in greater bond strength.

However, most laboratory studies in this review did not show the influence of such substances on adhesion or on, different concentrations of sodium hypochlorite. Only one study [18] showed that the maximum concentration of sodium hypochlorite (5.25%) when associated with specific resin cement (RelyX U100) reduced the bond strength. One of the reasons for this the double polymerization reaction of the resin cement. Calcium phosphates are formed as part of the reaction with hard tissues [42]. These low-energy bonds, along with the surface oxidation caused by sodium hypochlorite and the diffusion of by-products into the dentin, may have inhibited polymerization at the interface between dentin and cement, resulting in lower strength values [18], signaling that future studies are needed to investigate the possible mechanisms of interaction between endodontic irrigants and RelyX U100.

New therapeutic approaches have been used to help reduce endodontic infection [43-47], despite controversies in the literature, and brings in vogue the concern of the performance of these substances in the adhesion of glass fiber posts. Hashem et al. [31] showed that aPDT with a methylene blue photosensitizer showed the highest bond strength with the lowest number of failures in C-shaped mandibular root canals. Santana et al. [17] showed lower results in adhesion when using ozonated water, contrary to the study by Macedo et al. [30], which showed better results, showing the need for further studies to reduce these inconsistencies.

In this review, the most commonly used final irrigant was EDTA [17,18,21,24], a chelating agent that acts on the inorganic portion of the dentin, exposing the dentinal tubules, by removing the smear layer [48]. However, in this systematic review, in relation to the final irrigation with EDTA, the studies did not show significant results for bond strength. A greater possibility of compacting the smear layer in the dentinal tubules occurs during the shaping of the root canal, which can act as a barrier to the penetration and interaction of cement with the intraradicular dentin, which may be related to the decrease in adhesion strength [17]. Therefore, the use of chelators in the final irrigation is important for providing greater adhesion strength.

In the same context, sterile saline solution or distilled water can be used as an aid in final endodontic irrigation, or among the main irrigants chosen. However, these substances should not be used as main irrigants, as they have neither tissue-dissolving nor antimicrobial activity. These substances act by neutralizing the solutions used during root canal treatment, thus helping to increase bond strength [49].

Cleaning of the glass fiber posts did not show a pattern among the included articles. This can be an important reason for bond strength, because Kaif and Bis [24] showed that the most prevalent failure observed was at the interface between the post and resin cement, which was attributed to the chemical interactions between the outer layer of the glass fiber post and the cementing agent, such as cleaning the surface with 70% alcohol, 37% phosphoric acid or applying silane or ceramics, which should be the subject of future studies.

An important fact to be analyzed is the adhesive system and/or resin cements used to fix the glass fiber posts. Most studies have used adhesive systems to cement glass fiber posts. However, half articles [17,18,20,30] used self-etching and self-adhesive resin cement in their study groups, which is a material that offers resistance bonding similar to multi-step resin cements without the need for acid, primers or adhesives. This can have a great influence on the bond strength, making it higher, because they have indications for union with several substrates, in addition to a chemical and mechanical interaction, which could mask the influence of endodontic irrigation solutions.

Another topic on which studies diverge is the bond strength test, which can be an important issue in evaluation. This shows the lack of standardization among the surveys, as there is no standard test for this type of assessment, which may have influenced the differences in outcomes.

Although the present study was a review of laboratory studies, it is strongly relevant to daily clinical approaches. This is because glass fiber posts play an important role in the restoration of endodontically treated teeth and irrigation solutions are essential for successful root canal cleaning. To ensure the methodological quality of this systematic review, several criteria were rigorously followed, such as independent evaluations, broad electronic search with no date or language limit, grey literature search, and manual search. However, this study had some limitations. First, an adapted instrument was used to perform the quality assessment, as there was no specific tool for this type of laboratory study. Second, the heterogeneity of the studies, such as the different substances used during treatment, or even the different concentrations of the irrigants, different bond strength test methods and different types of root canal instrumentation, made it difficult to compare the studies and did not allow the performance of the meta-analysis.

Therefore, the heterogeneity between the studies did not allow a comparison for a true estimate, requiring well-designed future studies to clarify this issue and reinforce all the variables that may influence the adhesion of glass fiber posts to root dentin.

CONCLUSION

It was concluded that the included studies reported conflicting results regarding the influence of irrigating solutions and the different concentrations of NaOCl used during root canal instrumentation in the adhesion of glass fiber posts to the root dentin. Therefore, new studies are encouraged to help more assertively in the decision of professionals on this topic that is so common in clinical reality.

Author's Contribution

IGR, LSG, LSDT, MRRC, LAAA, LSA: Conception. IGR, LSG, MRRC: Manuscript Writing. IGR, LSG: Literature Search. IGR, LSG: Critical Evaluation of Studies and Data Extraction. LSA: Responsible for Consensus in Disparities. IGR, LSG, LSDT, MRRC, LAAA, LSA: Critically Reviewing the Final Draft of the Paper.

Conflict of Interest

No conflicts of interest declared concerning the publication of this article.

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Regulatory Statement

This systematic review was conducted through a search strategy in electronic databases. The search was restricted to publications in peer-reviewed journals, dissertations or theses, in which approval for ethics committee were obtained in their original work.

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