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Literature Review

Can Silanization Increase the Retention of Glass-fiber posts? A Systematic Review and Meta-analysis of *In Vitro* Studies

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Clinical Relevance

The improved retention of glass-fiber posts (GFPs) with a combination of post pretreatment and silanization is of particular interest because it could impact the clinical survival of GFP-retained restorations.

SUMMARY

The role of silanes in the bonding of resin luting agents to glass-fiber posts (GFPs) is a controversial topic, and the question still remains whether post silanization is able to improve the retention of GFPs luted into root canals. Thus, this study was designed to determine whether evidence exists to justify silanization of GFPs before cementation to increase their retention into root canals. *In vitro* studies that evaluated the retention of GFPs cemented into root canals or artificial substrates and that used silane coupling agents for pretreatment of the post were selected. Searches were carried out in PubMed and Scopus databases with no publication year or language limits. The last search was carried out in August 2014. Two distinct data analyses were carried out: 1) control group (no post pretreatment) vs silane only and 2) post pretreatment + silane vs silane only. Pooled-effect estimates were obtained by comparing the difference between each bond strength mean value and were expressed as the weighted mean difference between groups ($p \leq 0.05$). A total of 178 articles were found, and 23 were included in

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the review. The results were affected by the substrate into which the GFPs were luted (teeth or artificial devices). The analysis between control group and silane only for studies that used artificial devices favored the use of silane ($p<0.0001$), but considering studies that used teeth as substrate, no significant difference was observed ($p=0.35$). The analysis between silane only and pretreatment + silane did not show a significant difference between groups when artificial devices were used ($p=0.71$), whereas the analysis favored the use of post pretreatment + silane over silane ($p<0.00001$) only when the GFPs were luted into teeth. In conclusion, this review indicates that silanization improves the retention of GFPs luted into root canals provided that selective surface pretreatments are applied to the post before silanization.

INTRODUCTION

Glass-fiber posts (GFPs) have been developed to improve the optical effects of esthetic restorations[1,2] and are widely used for restoring endodontically treated teeth with insufficient coronal structure to serve as a core for the restoration.[3,4] The use of GFPs in cases in which the coronal tooth structure has been destroyed as a result of caries, trauma, or overaggressive endodontic procedures is gaining widespread acceptance among dental clinicians.[5,6] Together with the increased use of prefabricated posts, particularly GFPs, an increase has also been observed in the number of studies on this subject available in the literature. These studies evaluate different cementation protocols, adhesive systems, and surface treatments for improving the bond between resin cements and GFPs. Yet the main reason for failure of GFPs is still debonding, which occurs mainly as a result of the difficulties clinicians face in achieving proper adhesion to the intraradicular dentin.[7]

Various surface pretreatments of GFPs have been tested in the literature. These pretreatments can be divided into 1) physical/chemical means intended to create surface irregularities and expose the inorganic glass fibers and 2) chemical treatments applied to improve micromechanical and/or chemical attachment to the post.[8-12] Silanization is the most frequently used chemical pretreatment. Organosilane coupling agents are bifunctional molecules in which one end of the molecule is capable of reacting with inorganic glass fiber and the other end with the resin cement.[13] The role of silanes in the bonding of resin luting agents to GFPs is, however, a controversial topic.[2] Some studies[2,12,14] reported that silanization does not have a significant effect on the bond strength between resin cements and GFPs, whereas other studies[15-17] reported improved bonding by silanization. It is also a possibility that increased exposure of the glass fibers to physical/chemical pretreatments could have a synergic effect with silanization, thereby improving the retention of GFPs.

Despite the large number of *in vitro* studies in the literature, the question still remains whether post silanization is able to improve the retention of GFPs luted into root canals. This question cannot be easily answered because of the large variability in methods and results among primary studies. Therefore, the aim of this study was to systematically review the literature to determine whether there is *in vitro* evidence to justify the use of silanes to improve the bond strength of GFPs to intraradicular dentin. The hypothesis tested was that application of silane does not improve the retention of GFPs.

METHODS

Search Strategy

This systematic review was based on the guidelines of the *Cochrane Handbook for Systematic Reviews of Interventions*[18] and followed the four-phase flow diagram based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Statement.[19] Two electronic databases (PubMed and Scopus) were searched to identify manuscripts that could meet the following inclusion criteria: *in vitro* studies that evaluated the retention (bond strength) of GFPs luted into root canals (human or bovine teeth) or into artificial devices that used silane coupling agents for pretreatment of the post. The following search strategies were used: (glass fib* post*) AND (silane*); (endodontically-treated teeth) AND (silane*).

Screening and Selection

No publication year or language limits were set. The last search was carried out in August 2014. Reference lists of included studies were hand searched for additional articles. Excluded from the study were investigations reporting *in situ* studies, literature reviews, types of posts other than GFPs, and studies that did not use silane coupling agents for post pretreatment. Two reviewers (APM and RSO) independently screened the titles identified in the searches. If the title indicated possible inclusion,

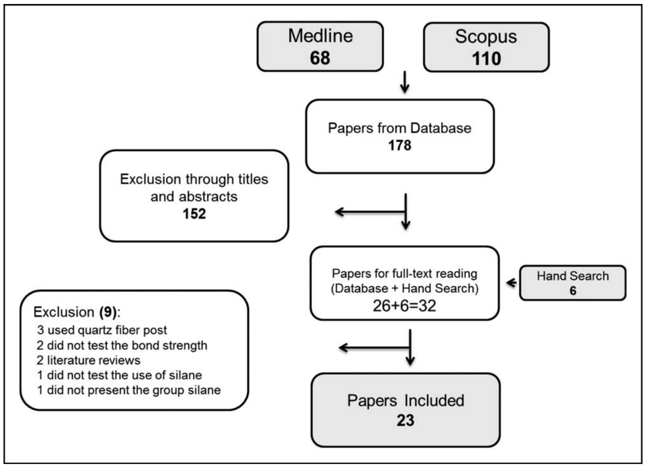

Figure 1. *Flow diagram of the systematic review according to the PRISMA Statement.*

the abstract was evaluated. After the abstracts were carefully appraised, the manuscripts considered eligible for the review and those with which there was some doubt were selected for full-text reading. In case of disagreement, a third reviewer (TPC) decided if the article should be included or not.

Data Collection

The two reviewers extracted all data simultaneously using a standardized outline. To make identification of variables found in the articles easier, the authors categorized similar information into groups (eg, post pretreatment used, bond strength mean reported in the articles). In case of measurement of bond strength values for different root thirds (push-out test, for instance), the arithmetic average of the values of the thirds was used. For studies that did not report bond strength means in tables, the authors were contacted via e-mail if data were missing or when more information was needed.

Statistical Analysis

Two distinct data analyses were carried out: 1) control group (untreated posts) vs silane only and 2) post pretreatment + silane vs silane only. Every possible comparison of bond strength between groups within the articles was simulated. Pooled-effect estimates were obtained by comparing the difference between each bond set of strength mean values and were expressed as the weighted mean difference between groups. A p-value < 0.05 was considered statistically significant (Z-test).

Statistical heterogeneity of the treatment effect among studies was assessed using the Cochran Q test, with a threshold p-value of 0.1, and the inconsistency I^2 test, in which values greater than 50% were considered indicative of high heterogeneity.[18] The analyses were carried out using a random-effects model. Taking into account that the analyses of substrate used in the test could present high heterogeneity, subgroup analyses considering artificial devices or teeth as distinct substrates were carried out to explore that influence on the results. All analyses were conducted using Review Manager Software, version 5.1 (The Nordic Cochrane Centre, The Cochrane Collaboration, Copenhagen, Denmark).

Assessment of Risk of Bias

Risk of bias of each included study was evaluated according to the description in the articles of the following parameters for the study quality assessment:[20] randomization of teeth, use of teeth free of caries or restoration, materials used according to the manufacturers' instructions, use of teeth with similar dimensions, endodontic treatment performed by the same operator, description of sample size calculation, and blinding of the operator of the testing machine. If the authors reported the parameter, the article had a "Y" (yes) on that specific parameter; if it was not possible to find the information, the article received an "N" (no). Articles that reported one to three items were classified as having high risk of bias, those that reported four or five items were classified as having medium risk of bias, and those reporting six or seven items were classified as having low risk of bias. Only articles that used teeth as substrate for luting the GFPs had the risk of bias classified; the other studies had other parameters evaluated except those related to the teeth.

RESULTS

Figure 1 shows the flow diagram of the systematic review. A total of 178 articles were found, and 26 were eligible for full-text analysis. The hand searches revealed six more articles for full-text reading. From the 32 studies, 23 articles were included in the review.[2,6,9,16,21-39] Nine studies were excluded for the following reasons: two did not test the bond strength;[40,41] two were literature reviews;[42,43] one study did not test the use of silane;[44] three studies used quartz-fiber posts;[45-47] and one did not present the group silane.[48] In the included studies, the main outcomes evaluated were type of pretreatment, substrate used for luting the GFPs, bond strength test, and resin cement (Tables 1 through 3).

Table 1: *Characteristics of Studies that Used Artificial Devices as Substrate*

Author, Year	Substrate	Comparison	Bond Strength Test	Conclusion
Aksornmuang and others, 2004[6]	Resin blocks	Control[a], dual-cure bonding agent, dual-cure bonding agent followed by light-curing for 20 s, silane coupling bonding agent, silane coupling bonding agent followed by light-curing for 20 s	Microtensile	Application of a silane coupling agent improved the bond strength of dual-cure resin core material to glass fiber posts.
Bitter and others, 2007[22]	Composite disk and plastic mold	Four different silane solutions	Push-out	The effects of silanization appeared to be clinically negligible.
Bitter and others, 2008[21]	Plastic mold	Silane and control[a]	Push-out	The silanization had negligible effects.
Cekic-Nagas and others, 2011[23]	Cylindrical plastic tube	Sandblasting was followed by the application of a silane; immersion in 9.6% hydrofluoric acid gel; silanization and control[a]	Micro–push-out	Different surface treatments of fiber posts might affect the bonding capacity of resin-core systems to these posts.
Costa Dantas and others, 2012[24]	Metal matrix	Silane, hydrofluoric acid, hydrofluoric acid + silane, plasma polymerization with argon, ethylenediamine plasma (EDA), control[a]	Push-out	Adhesion improvement was only observed after EDA treatment.
Debnath and others, 2003[25]	Fixed bottom grip	Two different silanes using various concentrations (1%, 5%, and 10%)	Pull-out	Five percent of samples had the highest strength.
Goracci and others, 2005[26]	Plastic matrix	Silane and control[a]	Microtensile	The application of a silane onto the post surface prior to building up the core significantly increased the post–core bond strength.
Magni and others, 2007[28]	Plastic matrix	Sandblasting, sandblasting + silanization, silanization, control[a]	Microtensile	Silanization was confirmed to be a reliabe method for improving the bond strength of resin luting agents to fiber posts.
Mosharraf and others 2012[29]	Cylindrical Plexiglas matrix	Silanization, sandblasting, treatment with 24% H_2O_2, and control[a]	Tensile	Although silanization and sandblasting can improve the bond strength, there was not any significant difference between surface treatments used.
Novais and others, 2011[32]	Plastic matrix	Three prehydrolyzed silanes and one two-component silane followed by air-drying temperatures, 23°C and 60°C	Push-out	The use of warm air-drying after silane application produced no increase in the bond strength between the fiber-reinforced composite post and the composite core. The two-component silane produced higher bond strength than all prehydrolyzed silanes when it was used with air-drying at room temperature.
Oliveira and others, 2011[16]	Elastomer mold	Silane and control[a]	Shear	Silanization of glass fiber posts is not necessary when self-adhesive resin cements are used.
Radovic and others, 2007[9]	Plastic matrix	Sandblasting or no pretreatment in each of the two groups; posts received three types of additional “chair-side” treatments: silane; adhesive; control[a]	Microtensile	Sandblasting may give an increase in microtensile strength to methacrylate-based glass fiber posts, eliminating the need to apply additional “chair-side” treatments.
Soares and others, 2008[36]	Metal stubs	Silane, silane and adhesive, airborne-particle abrasion with 50-μm Al_2O_3 and silane, airborne-particle abrasion, silane, and adhesive	Microtensile	Treatment with silane only was sufficient as a surface treatment for adhesive bonding.
Zicari and others, 2012[38]	Artificial root canals	Control[a]; silane, or coated with silica-coated alumina particles	Push-out	Laboratory testing revealed that different variables, such as type of post, composite, cement, and post-surface pretreatment, may influence the cement-post interface.

[a] *Control stands for no treatment*

Table 2: *Characteristics of Studies that Used Teeth as Substrate*

Author, Year	Substrate	Comparison	Bond Strength Test	Conclusion
Leme and others, 2013[27]	Human roots	Control[a]; silane; silane and Solobond; silane and Scotchbond Adhesive; silane and Excite	Push-out	Silane application may be necessary to improve the adhesion of fiber posts.
Liu and others, 2014[39]	Human maxillary central incisors and canines	Control[a], sandblasting, silanization, sandblasting followed by silanization	Push-out	Silanization of the post surface has no significant effect on the interfacial bond strength between the post and the resin cement.
Mosharraf and others, 2013[30]	Human maxillary incisors	Control[a];Silanization after etching with 20% H_2O_2; silanization after airborne-particle abrasion; silanization	Tensile	Application of hydrogen peroxide before silanization increased the bond strength between resin cements and fiber posts.
Narene and others, 2011[31]	Human root dentin	Silane, Cojet and Silane, 10% sodium ethoxide and silane and and 10% H_2O_2	Push-out	Cojet/silane showed the highest bond strength.
Perdigão and others, 2006[2]	Human maxillary central incisors and canines	Silane and control[a]	Push-out	The use of a silane coupling agent did not increase the push-out bond strengths of the fiber posts used in this study.
Rathke and others, 2009[33]	Human teeth	Silane and control[a]	Push-out	Silanization seems to be less relevant for intra–root canal bonding, but may have beneficial effects on post-to-core strengths.
Rödig and others, 2010[34]	Human teeth	Control[a], silanization, sandblasting + silanization and tribochemical coating	Push-out	Silanization of the posts seems to have no significant effect on bond strength.
Sahafi and others, 2003[35]	Human maxillary incisors	Roughening (sandblasting, hydrofluoric acid etching), application of primer (Alloy Primer, Metalprimer II, silane), or roughening followed by application of primer (sandblasting or etching followed by primer, Cojet treatment)	Shear bond strength	The bond strength of resin cement could be improved by surface treatment, Cojet treatment and sandblasting were the most effective pretreatments, and etching the posts used with hydrofluoric acid cannot be recommended.
Tian and others, 2012[37]	Human roots	Silane and control[a]	Pullout	Silanization of fiber posts does not make a difference in terms of preventing dislocation of a post.

[a] *Control indicates no treatment.*

Results of the meta-analyses are presented in Figures 2 and 3. The analysis between control group (untreated posts) and silane only for studies that used artificial devices (Figure 2) favored the use of silane ($p<0.0001$), with $I^2 = 94\%$. Considering studies that used teeth as substrate, no significant difference was observed between groups ($p=0.35$; $I^2=87\%$). The analysis between silane only vs pretreatment + silane (Figure 3) did not show a significant difference between groups when artificial devices were used ($p=0.71$; $I^2=81\%$), whereas the analysis favored the use of post pretreatment + silane ($p<0.00001$; $I^2=94\%$) over silane only when the GFPs were luted into teeth. The articles by Bitter and others[21,22] were not included in the analyses because the data necessary for analysis

Table 3: *Resin Cements Used in the Included Studies*

Author, Year	Comparison	Resin Cement	Conclusion
Aksornmuang and others, 2004[6]	Control[a], dual-cure bonding agent, dual-cure bonding agent followed by light-curing for 20 s, silane coupling bonding agent followed by bonding Clearfil Photobond with Porcelain Bond Activator, Clearfil Photobond with Porcelain Bond Activator followed by light-curing for 20 s	Clearfil DC Core (conventional)	Application of a silane coupling agent improved the bond strength of dual-cure resin core material to glass fiber posts.
Bitter and others, 2007[22]	Four different silane solutions	Panavia F (self-etch); PermaFlo DC (conventional); VariolinK II (conventional); RelyX Unicem (self-adhesive)	Variolink II demonstrated significantly higher bond strengths than the other investigated materials.
Bitter and others, 2008[21]	Silane and control[a]	Clearfil Core (conventional); MultiCore Flow (conventional)	Bond strengths were significantly affected by thermocycling, post type, and pretreatment, but in general not by the core material.
Cekic-Nagas and others, 2011[23]	Sandblasting was followed by the application of a silane; immersion in 9.6% hydrofluoric acid gel and silanization and control[a]	Biscore (resin-core material); Admira (composite resin)	The highest mean micro–push-out bond strength value was achieved in DT-light post, HF-silane treatment with the Biscore core material.
Costa Dantas and others, 2012[24]	Silane, hydrofluoric acid, hydrofluoric acid + silane, plasma polymerization with argon, ethylenediamine plasma (EDA), and the control[a]	RelyX Unicem (self-adhesive)	The RelyX Unicem cement showed an affinity with fiber posts treated with EDA plasma, which was observed for the highest bond strength.
Debnath and others, 2003[25]	Two different silanes using various concentrations (1%, 5%, and 10%)	Experimental resin	Five percent of samples had the highest strength.
Goracci and others, 2005[26]	Silane and control[a]	UnifilFlow; Tetric Flow (flowable composites)	Any combination of post and core material, post silanization increased the interfacial bond strength.
Leme and others, 2013[27]	Control[a]; silane; silane and Solobond; silane and Scotchbond Adhesive; silane and Excite	RelyX Unicem (self-adhesive)	Silane application may be necessary to improve the adhesion of fiber posts luted with the self-adhesive resin cement evaluated here.
Liu and others, 2014[39]	Control[a], sandblasting, silanization, sandblasting followed by silanization	DMG LUXACORE Smartmix Dual, Multilink Automix, Panavia F2.0, RelyX Unicem	It can be concluded that especially when DMG LUXACORE Smartmix Dual is used, air abrasion of glass fiber posts has a significantly helpful effect on the micro–push-out bond strength.
Magni and others, 2007[28]	Sandblasting, sandblasting + silanization, silanization, control[a]	Multilink (conventional); Variolink II (conventional); MultiCore Flow (conventional)	The type of luting agent did not significantly influence bond strength.
Mosharraf and others, 2012[29]	Silanization, sandblasting, treatment with 24% H_2O_2, and control[a]	Clearfil Photo Core Composite (composite resin)	Both silanization and sandblasting improved the bonding strength of fiber posts to composite resin core, but there were not any significant differences between these groups and the control group.
Mosharraf and others, 2013[30]	Control[a]; silanization after etching with 20% H_2O_2; silanization after airborne-particle abrasion; silanization	Panavia F 2.0 (self-etch)	Application of hydrogen peroxide before silanization increased the bond strength between resin cements and fiber posts.
Narene and others, 2011[31]	Silane, Cojet and Silane, 10% sodium ethoxide and silane and and 10% H_2O_2	Variolink II (conventional)	The results showed no significant differences between the control group and the silane treatment. The use of Cojet/silane associated with Variolink II showed the highest bond strength.

Table 3: Resin Cements Used in the Included Studies (cont.)

Author, Year	Comparison	Resin Cement	Conclusion
Novais and others, 2011[32]	Three prehydrolyzed silanes and one two-component silane followed by air-drying temperatures, 23°C and 60°C	Filtek™ Z250 Universal Restorative (composite resin)	The use of warm air-drying after silane application produced no increase in the bond strength between the fiber-reinforced composite post and the composite core.
Oliveira and others, 2011[16]	Silane and control[a]	Maxcem Elite (MXE, self-adhesive); RelyX Unicem clicker (UNI, self-adhesive); seT capsule (SET, self-adhesive); SmartCem 2 (SC2, self-adhesive); RelyX ARC (conventional)	For ARC, MXE, and SET, the silanated groups had higher bond strengths.
Perdigão and others, 2006[2]	Silane and control[a]	Post Cement Hi-X Base/Catalyst (conventional), Variolink II (conventional), ParaPost Resin Cement (conventional)	The use of a silane coupling agent did not increase the push-out bond strengths of the fiber posts used in this study.
Radovic and others, 2007[9]	Sandblasting or no pretreatment in each of the two groups; posts received three types of additional "chair-side" treatments: silane; adhesive; control[a]	Unifil Core (composite resin)	Sandblasting may give an increase in microtensile strength to methacrylate-based glass fiber posts, eliminating the need to apply additional "chair-side" treatments.
Rathke and others, 2009[33]	Silane and control[a]	Dyract Cem Plus (self-adhesive); Variolink II (conventional); Panavia F 2.0 (self-etch); RelyX Unicem (self-adhesive)	The highest mean post-to-dentin strength was measured using the etch-and-rinse luting agent, Variolink II, and the lowest mean post-to-dentin strength was measured using the etch-and-rinse luting agent, Dyract Cem Plus.
Rödig and others, 2010[34]	Control[a], silanization, sandblasting + silanization and tribochemical coating	Variolink II (conventional); Calibra (conventional); Luxacore (composite core material)	The significantly highest bond strengths were measured with the core buildup material Luxacore.
Sahafi and others, 2003[35]	Roughening (sandblasting, hydrofluoric acid etching), application of primer (Alloy Primer, Metalprimer II, silane), or roughening followed by application of primer (sandblasting or etching followed by primer, Cojet treatment)	ParaPost Resin Cement (conventional); Panavia F (self-etch)	Panavia F had significantly higher bond strength to ground ParaPost XH, Cerapost, and dentin than did ParaPost Cement.
Soares and others, 2008[36]	Silane, silane and adhesive, airborne-particle abrasion with 50-µm Al_2O_3 and silane, airborne-particle abrasion, silane, and adhesive	RelyX ARC (conventional)	Treatment with silane only was sufficient as a surface treatment for adhesive bonding.
Tian and others, 2012[37]	Silane and control[a]	ParaCore (PAR, composite resin); Relyx Unicem (RXU, self-adhesive); Relyx ARC (RXA, conventional)	PAR was significantly different from RXU and RXA ($p<0.05$). There was no statistically significant difference between RXU and RXA and between the use of silanization or not.
Zicari and others, 2012[38]	Control[a]; silane, or coated with silica-coated alumina particles	Variolink II (conventional); Clearfil Esthetic Cement (conventional); RelyX Unicem (self-adhesive)	A significantly higher push-out bond strength was recorded for the self-adhesive cement Unicem (3M ESPE).

[a] *Control indicates no treatment.*

Study or Subgroup	Control Mean	Control SD	Control Total	Silane Mean	Silane SD	Silane Total	Weight	Mean Difference IV, Random, 95% CI
1.2.1 Artificial Devices								
Dantas et al. 2012	13.9	1.4	8	11.7	3.1	8	1.8%	2.20 [-0.16, 4.56]
Goracci (1) et al. 2005	9.05	5.69	40	11.11	2.49	40	2.0%	-2.06 [-3.98, -0.14]
Goracci (2) et al. 2005	9.05	5.69	40	12.88	3.16	40	1.9%	-3.83 [-5.85, -1.81]
Goracci (3) et al. 2005	10.74	5.65	40	11.11	2.49	40	2.0%	-0.37 [-2.28, 1.54]
Goracci et al. 2005	10.74	5.65	40	12.88	3.16	40	1.9%	-2.14 [-4.15, -0.13]
Magni (1) et al. 2007	19.42	10.52	26	17.5	11.28	28	0.8%	1.92 [-3.89, 7.73]
Magni (2) et al. 2007	12.73	7.23	32	17.5	11.28	28	1.0%	-4.77 [-9.64, 0.10]
Magni (3) et al. 2007	13.4	6.01	38	17.5	11.28	28	1.1%	-4.10 [-8.69, 0.49]
Magni (4) et al. 2007	19.42	10.52	26	19.75	8.67	40	1.0%	-0.33 [-5.18, 4.52]
Magni (5) et al. 2007	12.73	7.23	32	19.75	8.67	40	1.3%	-7.02 [-10.69, -3.35]
Magni (6) et al. 2007	13.4	6.01	38	19.75	8.67	40	1.5%	-6.35 [-9.65, -3.05]
Magni (7) et al. 2007	19.42	10.52	26	17.08	9.68	37	1.0%	2.34 [-2.77, 7.45]
Magni (8) et al. 2007	12.73	7.23	32	17.08	9.68	37	1.2%	-4.35 [-8.35, -0.35]
Magni et al. 2007	13.4	6.01	38	17.08	9.68	37	1.3%	-3.68 [-7.34, -0.02]
Mosharraf (1) et al. 2012	11.51	2.99	8	14.39	1.85	8	1.8%	-2.88 [-5.32, -0.44]
Mosharraf (2) et al. 2012	12.44	2.37	8	14.39	1.85	8	1.9%	-1.95 [-4.03, 0.13]
Mosharraf (3) et al. 2012	12.44	2.37	8	14.15	1.23	8	2.0%	-1.71 [-3.56, 0.14]
Mosharraf et al. 2012	11.51	2.99	8	14.15	1.23	8	1.8%	-2.64 [-4.88, -0.40]
Novais (1) et al. 2011	18.12	0.82	70	20.29	2.32	70	2.3%	-2.17 [-2.75, -1.59]
Novais (2) et al. 2011	18.12	0.82	70	19.7	2.88	70	2.3%	-1.58 [-2.28, -0.88]
Novais (3) et al. 2011	18.12	0.82	70	20.7	2.33	70	2.3%	-2.58 [-3.16, -2.00]
Novais (4) et al. 2011	18.12	0.82	70	19.37	1.04	70	2.4%	-1.25 [-1.56, -0.94]
Novais (5) et al. 2011	18.12	0.82	70	18.52	2.84	70	2.3%	-0.40 [-1.09, 0.29]
Novais (6) et al. 2011	18.12	0.82	70	19.91	2.27	70	2.3%	-1.79 [-2.36, -1.22]
Novais (7) et al. 2011	18.12	0.82	70	21.66	2.49	70	2.3%	-3.54 [-4.15, -2.93]
Novais et al. 2011	18.12	0.82	70	19.44	1.32	70	2.3%	-1.32 [-1.68, -0.96]
Oliveira (1) et al. 2011	5.9	2	20	11.2	3.4	20	2.0%	-5.30 [-7.03, -3.57]
Oliveira (10) et al. 2011	5.9	2	20	9	3.6	20	2.0%	-3.10 [-4.90, -1.30]
Oliveira (11) et al. 2011	5.9	2	20	13.1	2.4	20	2.1%	-7.20 [-8.57, -5.83]
Oliveira (12) et al. 2011	5.9	2	20	9.6	3.3	20	2.0%	-3.70 [-5.39, -2.01]
Oliveira (13) et al. 2011	5.9	2	20	9.6	2.5	20	2.1%	-3.70 [-5.10, -2.30]
Oliveira (14) et al. 2011	15.2	2.8	20	11.2	3.4	20	2.0%	4.00 [2.07, 5.93]
Oliveira (15) et al. 2011	15.2	2.8	20	9	3.6	20	1.9%	6.20 [4.20, 8.20]
Oliveira (16) et al. 2011	15.2	2.8	20	13.1	2.4	20	2.1%	2.10 [0.48, 3.72]
Oliveira (17) et al. 2011	15.2	2.8	20	9.6	3.3	20	2.0%	5.60 [3.70, 7.50]
Oliveira (18) et al. 2011	15.2	2.8	20	9.6	2.5	20	2.0%	5.60 [3.95, 7.25]
Oliveira (19) et al. 2011	6.9	1.4	20	11.2	3.4	20	2.1%	-4.30 [-5.91, -2.69]
Oliveira (2) et al. 2011	6.9	1.4	20	9	3.6	20	2.0%	-2.10 [-3.79, -0.41]
Oliveira (20) et al. 2011	6.9	1.4	20	13.1	2.4	20	2.2%	-6.20 [-7.42, -4.98]
Oliveira (21) et al. 2011	6.9	1.4	20	9.6	3.3	20	2.1%	-2.70 [-4.27, -1.13]
Oliveira (22) et al. 2011	6.9	1.4	20	9.6	2.5	20	2.2%	-2.70 [-3.96, -1.44]
Oliveira (23) et al. 2011	7.8	1.4	20	11.2	3.4	20	2.1%	-3.40 [-5.01, -1.79]
Oliveira (24) et al. 2011	7.8	1.4	20	9	3.6	20	2.0%	-1.20 [-2.89, 0.49]
Oliveira (3) et al. 2011	7.8	1.4	20	13.1	2.4	20	2.2%	-5.30 [-6.52, -4.08]
Oliveira (4) et al. 2011	7.8	1.4	20	9.6	3.3	20	2.1%	-1.80 [-3.37, -0.23]
Oliveira (5) et al. 2011	7.8	1.4	20	9.6	2.5	20	2.2%	-1.80 [-3.06, -0.54]
Oliveira (6) et al. 2011	3.8	1.4	20	11.2	3.4	20	2.1%	-7.40 [-9.01, -5.79]
Oliveira (7) et al. 2011	3.8	1.4	20	9	3.6	20	2.0%	-5.20 [-6.89, -3.51]
Oliveira (8) et al. 2011	3.8	1.4	20	13.1	2.4	20	2.2%	-9.30 [-10.52, -8.08]
Oliveira (9) et al. 2011	3.8	1.4	20	9.6	3.3	20	2.1%	-5.80 [-7.37, -4.23]
Oliveira et al. 2011	3.8	1.4	20	9.6	2.5	20	2.2%	-5.80 [-7.06, -4.54]
Zicari et al. 2012	8.5	3.1	216	8.8	3.4	216	2.3%	-0.30 [-0.91, 0.31]
Subtotal (95% CI)			**1764**			**1791**	**100.0%**	**-2.37 [-3.02, -1.73]**
Heterogeneity: Tau² = 4.55; Chi² = 848.79, df = 51 (P < 0.00001); I² = 94%								
Test for overall effect: Z = 7.23 (P < 0.00001)								
1.2.2 Teeth								
Leme et al. 2013	2.7	1.18	30	5.93	2.3	30	4.2%	-3.23 [-4.16, -2.30]
Liu (1) et al. 2014	8.44	2.38	32	9.46	1.66	32	4.2%	-1.02 [-2.03, -0.01]
Liu (2) et al. 2014	8.79	4.11	32	9.83	5.9	32	3.8%	-1.04 [-3.53, 1.45]
Liu (3) et al. 2014	11.77	2.04	32	16.4	5.92	32	3.9%	-4.63 [-6.80, -2.46]
Liu (4) et al. 2014	14.77	2.77	32	15.29	3.08	32	4.1%	-0.52 [-1.96, 0.92]
Mosharraf et al. 2013	8.13	3.7	10	13.79	5.62	10	3.2%	-5.66 [-9.83, -1.49]
Narene et al. 2011	10.43	3.8	30	10.73	3.5	30	4.0%	-0.30 [-2.15, 1.55]
Perdigão (1) et al. 2006	13.7	7.2	27	13	5.9	27	3.4%	0.70 [-2.81, 4.21]
Perdigão (2) et al. 2006	10.5	6.5	27	13	5.9	27	3.5%	-2.50 [-5.81, 0.81]
Perdigão (3) et al. 2006	13.7	7.2	27	13.9	6.9	27	3.3%	-0.20 [-3.96, 3.56]
Perdigão et al. 2006	10.5	6.5	27	13.9	6.9	27	3.4%	-3.40 [-6.98, 0.18]
Rathke (1) et al. 2009	22.19	3.85	5	19.26	9.26	5	1.7%	2.93 [-5.86, 11.72]
Rathke (10) et al. 2009	32.41	4.37	5	19.26	9.26	5	1.6%	13.15 [4.17, 22.13]
Rathke (11) et al. 2009	23.37	4.26	5	19.26	9.26	5	1.6%	4.11 [-4.82, 13.04]
Rathke (12) et al. 2009	24.68	6.41	5	19.26	9.26	5	1.4%	5.42 [-4.45, 15.29]
Rathke (13) et al. 2009	32.41	4.37	5	29.66	5.87	5	2.3%	2.75 [-3.66, 9.16]
Rathke (14) et al. 2009	22.19	3.85	5	29.66	5.87	5	2.4%	-7.47 [-13.62, -1.32]
Rathke (15) et al. 2009	23.37	4.26	5	29.66	5.87	5	2.3%	-6.29 [-12.65, 0.07]
Rathke (2) et al. 2009	24.68	6.41	5	29.66	5.87	5	2.0%	-4.98 [-12.60, 2.64]
Rathke (3) et al. 2009	22.19	3.85	5	22.18	6.2	5	2.3%	0.01 [-6.39, 6.41]
Rathke (4) et al. 2009	32.41	4.37	5	22.18	6.2	5	2.2%	10.23 [3.58, 16.88]
Rathke (5) et al. 2009	23.37	4.26	5	22.18	6.2	5	2.3%	1.19 [-5.40, 7.78]
Rathke (6) et al. 2009	24.68	6.41	5	22.18	6.2	5	1.9%	2.50 [-5.32, 10.32]
Rathke (7) et al. 2009	22.19	3.85	5	23.06	7.23	5	2.1%	-0.87 [-8.05, 6.31]
Rathke (8) et al. 2009	32.41	4.37	5	23.06	7.23	5	2.0%	9.35 [1.95, 16.75]
Rathke (9) et al. 2009	23.37	4.26	5	23.06	7.23	5	2.0%	0.31 [-7.05, 7.67]
Rathke et al. 2009	24.68	6.41	5	23.06	7.23	5	1.7%	1.62 [-6.85, 10.09]
Rodig (2) et al. 2010	18.84	10.88	30	4.16	3.49	30	3.2%	14.68 [10.59, 18.77]
Rodig (3) et al. 2010	9.81	2.07	30	4.16	3.49	30	4.1%	5.65 [4.20, 7.10]
Rodig et al. 2010	18.84	10.88	30	8	3.46	30	3.2%	10.84 [6.75, 14.93]
Rödig (1) et al. 2010	9.81	2.07	30	8	3.46	30	4.1%	1.81 [0.37, 3.25]
Sahafi (1) et al 2003	14.2	6	11	15.2	4.5	11	3.0%	-1.00 [-5.43, 3.43]
Sahafi (2) et al 2003	14.2	6	11	12.9	3.1	11	3.2%	1.30 [-2.69, 5.29]
Sahafi (3) et al 2003	10.8	5.9	11	12.9	3.1	11	3.2%	-2.10 [-6.04, 1.84]
Sahafi et al 2003	10.8	5.9	11	15.2	4.5	11	3.1%	-4.40 [-8.79, -0.01]
Subtotal (95% CI)			**550**			**550**	**100.0%**	**0.69 [-0.76, 2.14]**
Heterogeneity: Tau² = 12.84; Chi² = 264.56, df = 34 (P < 0.00001); I² = 87%								
Test for overall effect: Z = 0.93 (P = 0.35)								
Test for subgroup differences: Chi² = 14.30, df = 1 (P = 0.0002), I² = 93.0%								

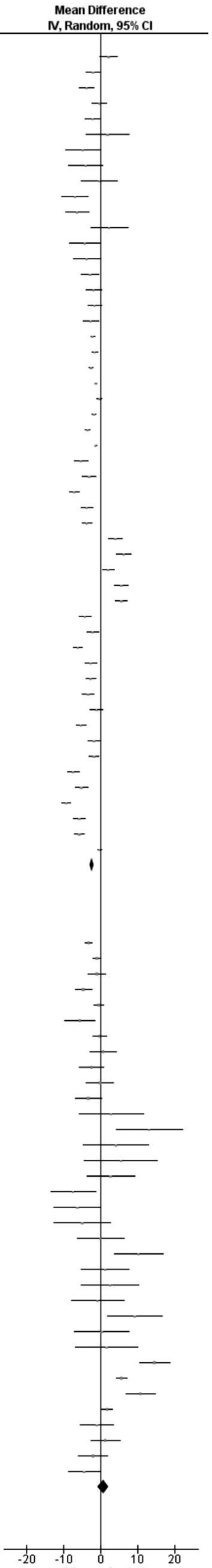

Figure 2. *Forest plot for the analysis between control group (untreated posts) and silane only. Studies that used artificial devices favored the use of silane, whereas studies that used teeth as a substrate for luting the posts reflected no significant difference.*

Study or Subgroup	Silane Mean	Silane SD	Silane Total	Pre-treatment + Silane Mean	Pre-treatment + Silane SD	Pre-treatment + Silane Total	Weight	Mean Difference IV, Random, 95% CI
1.3.1 Artificial Devices								
Dantas et al. 2012	11.7	3.1	8	12.3	5.4	8	5.8%	-0.60 [-4.91, 3.71]
Magni (1) et al. 2007	17.5	11.28	28	22.23	5.63	35	5.5%	-4.73 [-9.31, -0.15]
Magni (2) et al. 2007	17.5	11.28	28	17.03	8.36	45	5.3%	0.47 [-4.37, 5.31]
Magni (3) et al. 2007	17.5	11.28	28	20.03	7.14	42	5.4%	-2.53 [-7.23, 2.17]
Magni (4) et al. 2007	19.75	8.67	40	22.23	5.63	35	6.9%	-2.48 [-5.75, 0.79]
Magni (5) et al. 2007	19.75	8.67	40	17.03	8.36	45	6.5%	2.72 [-0.91, 6.35]
Magni (6) et al. 2007	19.75	8.67	40	20.03	7.14	42	6.7%	-0.28 [-3.73, 3.17]
Magni (7) et al. 2007	17.08	9.68	37	22.23	5.63	35	6.5%	-5.15 [-8.78, -1.52]
Magni (8) et al. 2007	17.08	9.68	37	17.03	8.36	45	6.2%	0.05 [-3.91, 4.01]
Magni et al. 2007	17.08	9.68	37	20.03	7.14	42	6.3%	-2.95 [-6.74, 0.84]
Radovic et al. 2007	21.67	7.13	32	19.76	6.16	32	6.9%	1.91 [-1.35, 5.17]
Soares (1) et al. 2008	27.8	3.2	10	26.1	4.3	10	6.8%	1.70 [-1.62, 5.02]
Soares (2) et al. 2008	27.8	3.2	10	24.9	2.1	10	7.9%	2.90 [0.53, 5.27]
Soares et al. 2008	27.8	3.2	10	23.3	0.9	10	8.2%	4.50 [2.44, 6.56]
Zicari et al. 2012	8.8	3.4	216	11.3	3.9	216	9.2%	-2.50 [-3.19, -1.81]
Subtotal (95% CI)			**601**			**652**	**100.0%**	**-0.32 [-2.01, 1.36]**
Heterogeneity: Tau² = 7.99; Chi² = 75.01, df = 14 (P < 0.00001); I² = 81%								
Test for overall effect: Z = 0.38 (P = 0.71)								
1.3.2 Teeth								
Liu (1) et al. 2014	9.46	1.66	32	13.23	5.09	32	4.3%	-3.77 [-5.62, -1.92]
Liu (2) et al. 2014	9.83	5.9	32	8.95	2.39	32	4.2%	0.88 [-1.33, 3.09]
Liu (3) et al. 2014	16.4	5.92	32	12.93	3.65	32	4.2%	3.47 [1.06, 5.88]
Liu (4) et al. 2014	15.29	3.08	32	15.33	4.77	32	4.3%	-0.04 [-2.01, 1.93]
Mosharraf (1) et al. 2013	13.79	15.65	10	16.57	5.27	30	2.0%	-2.78 [-12.66, 7.10]
Mosharraf et al. 2013	13.79	5.62	30	11.72	5.07	30	4.1%	2.07 [-0.64, 4.78]
Narene (1) et al. 2011	10.73	3.5	30	15.5	4.2	30	4.3%	-4.77 [-6.73, -2.81]
Narene (2) et al. 2011	10.73	3.5	30	11.9	3.5	30	4.3%	-1.17 [-2.94, 0.60]
Narene et al. 2011	10.73	3.5	30	12.04	3.9	30	4.3%	-1.31 [-3.19, 0.57]
Rodig (1) et al. 2010	4.16	3.49	30	8.69	3.65	30	4.3%	-4.53 [-6.34, -2.72]
Rodig (2) et al. 2010	4.16	3.49	30	11.62	4.08	30	4.3%	-7.46 [-9.38, -5.54]
Rodig (3) et al. 2010	4.16	3.49	30	10.39	3.85	30	4.3%	-6.23 [-8.09, -4.37]
Rodig et al. 2010	4.16	3.49	30	18.43	4.75	30	4.3%	-14.27 [-16.38, -12.16]
Rödig (4) et al. 2010	8	3.46	30	8.69	3.65	30	4.3%	-0.69 [-2.49, 1.11]
Rödig (5) et al. 2010	8	3.46	30	11.62	4.08	30	4.3%	-3.62 [-5.53, -1.71]
Rödig (6) et al. 2010	8	3.46	30	10.39	3.85	30	4.3%	-2.39 [-4.24, -0.54]
Rödig (7) et al. 2010	8	3.46	30	18.43	4.75	30	4.3%	-10.43 [-12.53, -8.33]
Sahafi (1) et al 2003	15.2	4.5	11	34.3	8.5	11	3.2%	-19.10 [-24.78, -13.42]
Sahafi (2) et al 2003	15.2	4.5	11	22.2	3.8	11	3.9%	-7.00 [-10.48, -3.52]
Sahafi (3) et al 2003	12.9	3.1	11	34.3	8.5	11	3.3%	-21.40 [-26.75, -16.05]
Sahafi (4) et al 2003	12.9	3.1	11	22.2	3.8	11	4.1%	-9.30 [-12.20, -6.40]
Sahafi (5) et al. 2003	15.2	4.5	11	16.2	7	11	3.4%	-1.00 [-5.92, 3.92]
Sahafi (6) et al. 2003	15.2	4.5	11	13.1	3.5	11	3.9%	2.10 [-1.27, 5.47]
Sahafi (7) et al. 2003	12.9	3.1	11	16.2	7	11	3.6%	-3.30 [-7.82, 1.22]
Sahafi et al 2003	12.9	3.1	11	13.1	3.5	11	4.1%	-0.20 [-2.96, 2.56]
Subtotal (95% CI)			**586**			**606**	**100.0%**	**-4.44 [-6.32, -2.55]**
Heterogeneity: Tau² = 20.45; Chi² = 374.41, df = 24 (P < 0.00001); I² = 94%								
Test for overall effect: Z = 4.62 (P < 0.00001)								
Test for subgroup differences: Chi² = 10.16, df = 1 (P = 0.001), I² = 90.2%								

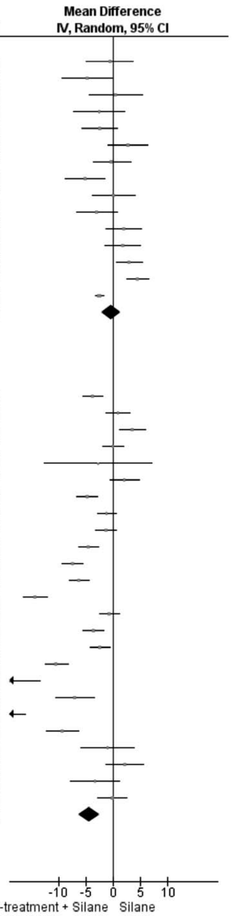

Figure 3. *Forest plot for the analysis between silane only vs pretreatment + silane. No significant difference between groups was observed when artificial devices were used, whereas the analysis favored the use of post pretreatment + silane over silane only when the posts were luted into teeth.*

were not obtained after an attempt at e-mail contact with the authors.

Table 3 shows that a wide variety of resin cements were used in the selected studies, with varied results reported. One study[27] reported that post silanization improved the adhesion of GFPs luted with self-adhesive resin cements, and 12 studies[6,22,23,26,28-32,34-36] showed a positive effect of silane on the bond strength of posts luted with regular resin cements. Yet other studies showed no significant improvement in the retention of GFPs by silanization using self-adhesive,[24] regular resin cements,[2,9,21] or both.[39] It was not possible to observe any interaction among resin cements, post silanization, or other post treatments.

Risk of Bias

The nine articles[2,27,30,31,33-35,37,39] that used teeth as substrate had the risk of bias classified as high. From the studies that used artificial devices as substrate, 11 articles[6,9,21-24,26,28,32,36,38] reported that the materials were used according to manufacturers' instructions, and none reported sample size calculation or whether blinding of the operator of the testing machine was used (Table 4).

DISCUSSION

This systematic review is the first to summarize the *in vitro* data on the influence of silanization on the retention of GFPs into root canals. Several materials, surface treatments, and cementation strategies have been tested in the literature in an endeavor to increase the retention of GFPs into root canals. Analysis of all available data together could clarify the role of silane with regard to the performance of luted GFPs and give support for the clinician in terms of evidence-based decision making. The hypothesis tested that application of silane does not improve the retention of GFPs was rejected.

Several surface pretreatments for posts have been tested to improve the bonding between GFPs and resin cements.[10-12,26,41,49-51] Pretreatment procedures aim to generally improve the adhesion to GFPs by facilitating chemical and/or mechanical

Table 4: *Risk of Bias Considering Aspects Reported in the "Materials and Methods" Section*

Author, Year of Article	Important Aspects Related to "Materials and Methods" Section—Yes (Y), No (N), Not Applied (NA)							
	Teeth Randomization	**Teeth Free of Caries or Restoration**	**Materials Used According to Manufacturer's Instructions**	**Teeth with Similar Dimensions**	**Endodontic Treatment Performed by the Same Operator**	**Sample Size Calculation**	**Blinding of the Operator of the Test Machine**	**Risk of Bias**
Aksornmuang and others, 2004[6]	NA	NA	Y	NA	NA	N	N	NA
Bitter and others, 2007[22]	NA	NA	Y	NA	NA	N	N	NA
Bitter and others, 2008[21]	NA	NA	Y	NA	NA	N	N	NA
Cekic-Nagas and others, 2011[23]	NA	NA	Y	NA	NA	N	N	NA
Costa Dantas and others, 2011[24]	NA	NA	Y	NA	NA	N	N	NA
Debnath and others, 2003[25]	NA	NA	N	NA	NA	N	N	NA
Goracci and others, 2005[26]	NA	NA	Y	NA	NA	N	N	NA
Leme and others, 2013[27]	Y	N	Y	N	Y	N	N	High
Liu and others, 2014[39]	Y	N	N	N	N	N	N	High
Magni and others, 2007[28]	NA	NA	Y	NA	NA	N	N	NA
Mosharraf and others, 2012[29]	NA	NA	N	NA	NA	N	N	NA
Mosharraf and others, 2013[30]	N	Y	N	N	Y	N	N	High
Narene and others, 2011[31]	Y	Y	N	N	N	N	N	High
Novais and others, 2011[32]	NA	NA	Y	NA	NA	N	N	NA
Oliveira and others, 2011[16]	NA	NA	N	NA	NA	N	N	NA
Perdigão and others, 2006[2]	Y	N	N	N	N	Y	N	High
Radovic and others, 2007[9]	NA	NA	Y	NA	NA	N	N	NA
Rathke and others, 2009[33]	N	Y	Y	Y	NA	N	N	High
Rödig and others, 2010[34]	N	N	Y	N	Y	N	N	High
Sahafi and others, 2003[35]	N	N	Y	N	NA	N	N	High
Soares and others, 2008[36]	NA	NA	Y	NA	NA	N	N	NA
Tian and others, 2012[37]	Y	N	Y	N	N	N	N	NA
Zicari and others, 2012[38]	NA	NA	Y	NA	NA	N	N	NA

interaction between the different substrates at the bonded interface. The results of the present study indicate that silanization improves the retention of GFPs only when appropriate surface pretreatment of the post is performed before application of silane. This finding is explained by the fact that the glass fibers in untreated posts are covered by the highly cross-linked, low-reactive epoxy resin. Application of surface pretreatments might expose the glass fibers, allowing more effective formation of siloxane bonds between silane and glass. The rough surface left by the surface pretreatments may also aid in improving micromechanical retention at the post-resin cement interface.[46,52]

Previous studies[16,17] have clearly indicated the positive effect that silanization might have on the bond strength between GFPs and methacrylate-based materials. However, the question that remained unanswered was whether post silanization would have a role in improving its retention into root canals. In this study, investigations that did not lute the GFPs into dental root canals or artificial root canals were excluded, since the retention analysis was the main focus here. It was noted that silanization alone is not sufficient to improve the retention of GFPs luted into root canals, whereas the combination of surface pretreatment + silanization was able to improve the retention into root canals.

Post debonding is the main reason for clinical failure of GFP-retained restorations.[7] This clinical failure type might result from poor interaction between resin cement and intraradicular dentin and/or poor interaction of resin cement and post. The findings of the present study indicate that when the posts were luted into natural root canals, the combination of post pretreatment + silanization significantly improved the post retention. This result is explained by a better interaction between resin cement and post surface leading to a situation in which the mechanical stresses during testing concentrate at the interface between the resin cement and root dentin only. In such a scenario, the better mechanical keying at the post-cement interface does not contribute significantly toward stress concentration and/or magnification during the test, leading to higher bond strength values.

In contrast to the findings from studies performed using extracted teeth, no significant improvement in the retention of GFPs was observed for the combination of post pretreatment + silane when the posts were luted into artificial devices. When artificial devices are used, there is no dentin-resin cement interface; in other words, the resin cements used to lute the posts do not interact with dental hard tissues but rather with synthetic materials such as methacrylate-based composites. In such a scenario, the interaction of the cement with the artificial devices is expected to be improved as compared with that associated with dentin, which is acknowledged to be the weakest link in adhesive bonding. In addition, the use of artificial devices usually does not have the same limitations that are imposed upon extracted teeth, such as great variability in root canal diameter and resin cement film thickness between specimens. Therefore, it is suggested that the use of artificial devices to lute GFPs should be restricted to situations in which the post-cement interface is the main focus of the investigation.

Among the surface pretreatments tested in the included studies, sandblasting stands out as the pretreatment most often used. A total of 80% of comparisons carried out here on the effect of surface pretreatments on the retention of GFPs into artificial devices, and ~62% of the comparisons on the retention of GFPs into root canals, used sandblasting as pretreatment. As an overall result, the present findings indicate a positive effect of surface pretreatments before silanization; however, this result should be mainly concentrated at the combination of sandblasting + silanization on the retention of GFPs, because most studies only tested that specific combination. That notwithstanding, surface pretreatments that only selectively expose the glass fiber by chemical means could be considered the ideal situation to enhance the silanization effect. Sandblasting is known not to be selective in exposing the glass and may cause structure damage to the post, although there is no evidence regarding whether this could affect the mechanical stability of post-and-core restored teeth.

Different mechanical tests to measure the bond strength and a wide variety of adhesives and resin cements are reported in the *in vitro* literature, resulting in a tough scenario for one seeking comparisons between the results of different studies. Authors sometimes do not follow the manufacturers' directions in applying materials, underscoring the problem of comparing studies in the literature. Systematic reviews have the advantage of analyzing the literature data together, but they also suffer from the limitation that the methods employed in distinct studies differ to extents that often are difficult to predict. With that in mind, we have used a tool to assess the risk of bias of each study.

The results indicate that all selected studies present a high risk of bias, demonstrating that variables that could influence the results of the studies were not controlled by researchers, favoring the high heterogeneity of the findings in the present study. However, the risk of bias assessment can be subjective and should be interpreted as such. Heterogeneity among the studies was in fact expected, since it is known that laboratory analyses have intrinsic variability related to experimental setups, procedures for specimen preparation, and the mechanical tests themselves.

The results of the present review should be interpreted with caution considering that laboratory studies have intrinsic limitations in terms of simulating *in vivo* conditions. However, the improved retention of GFPs by a combination of post pretreatment and silanization is of particular interest, bearing in mind that it could affect the clinical survival of GFP-retained restorations. Additionally, clinicians should be aware of the beneficial effects that post silanization might have on the clinical performance of restoration, particularly because post silanization is a procedure that might be overlooked in the clinical practice if it is regarded as being of minor significance. Furthermore, it is important to know if the posts are commercially available in a pre-silanized or pretreatment form by the manufacturer. For this reason, following the manufacturers' recommendations when preparing the GFPs before luting is necessary. Regardless of the results presented here, well-designed randomized controlled clinical trials (RCTs) with long follow-up periods would provide the ultimate answer as to whether use of a silane coupling agent could result in improved clinical success rates for GFP-retained restorations. However, it is known that RCTs cannot be used indiscriminately to support all clinical decisions. Therefore, the overall results of the present study favor the combination of post surface pretreatment and silanization for the retention of GFPs.

CONCLUSIONS

Analysis of the *in vitro* literature indicates that silanization improves the retention of GFPs luted into root canals provided that selective surface pretreatments are applied to the post before silanization.

Regulatory Statement

This study was conducted at the Federal University of Pelotas, Graduate Program in Dentistry, in Brazil.

Conflict of Interest

The authors of this manuscript certify that they have no proprietary, financial, or other personal interest of any nature or kind in any product, service, and/or company that is presented in this article.

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