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SYSTEMATIC REVIEW

Comparing survival rates of endodontically treated teeth restored either with glass-fiber-reinforced or metal posts: A systematic review and meta-analyses

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ABSTRACT

Statement of problem. When restoring endodontically treated teeth, a post system is indicated to retain a core. Clinicians can choose from different post materials and types. However, the literature is inconclusive on the long-term clinical performance of available post systems.

Purpose. The purpose of this systematic review and meta-analysis was to analyze the survival and failure rates of endodontically treated teeth restored either with glass-fiber-reinforced or metal posts.

Material and methods. The research question was formulated by following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines by using the Population, Intervention, Comparison, Outcome, Study Type (PICOS) tool. Medline (PubMed), Embase, and Scopus searches complemented by manual search were performed for randomized controlled clinical trials with a follow-up of at least 2 years. Two independent authors performed screening and data extraction of the articles. Meta-analyses were performed with the RevMan software program. Homogeneity was checked by using chi2 and I^2 tests, and random-effects meta-analyses were applied. Odds ratio and 95% confidence interval were calculated (α=.05). The publication bias was evaluated by using funnel plots and the Begg and Egger tests.

Results. A total of 184 studies were retrieved through the electronic searches, and an additional 4 through the hand search. After title- and abstract-level exclusion, 23 studies remained for full-text analyses, of which 7 were selected for data extraction. Meta-analyses revealed an overall survival rate of 92.8% for endodontically treated teeth restored with glass-fiber-reinforced posts compared with 78.1% of those restored with metal posts. No statistically significant difference (P>.05) was found in the survival, success, or failure rates.

Conclusions. No statistically significant differences were found between the survival and failure rates of endodontically treated teeth restored either with glass-fiber-reinforced or metal posts. The overall survival rate was 92.8% for glass fiber posts and 78.1% for metal posts. Both are reliable materials when a significant amount of coronal tooth structure is missing and treatment with a post is indicated. (J Prosthet Dent 2022;■:■-■)

Restoring endodontically treated teeth with a significant loss of coronal tooth structure requires a core retained with a post.[1] Most widely used dental materials for posts are metal or fiber-reinforced composite.[2,3] Metal can be cast custom-made or prefabricated,[4-12] and a cast metal post-and-core is considered the standard treatment; however, concerns over vertical root fracture, corrosion, toxicity, and nonesthetic appearance have been expressed.[13-16] A cast metal post also requires 2 visits and entails a dental laboratory fee.[17] Prefabricated metal posts are provided during a single visit, and post space preparation can be less extensive.[2,17] However, prefabricated metal posts have also been associated with irreparable failures and poor esthetics.[18]

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Clinical Implications

This systematic review evaluated and summarized the findings of up-to-date clinical studies on the survival and failure rates of endodontically treated teeth restored either with glass-fiber-reinforced or metal posts. No statistically significant difference was found in their survival and success rates. Thus, both are reliable materials when a significant amount of coronal tooth structure is missing and treatment with a post is indicated.

Fiber-reinforced posts have improved esthetics and have been reported to have promising mechanical properties. Their modulus of elasticity, being similar to that of dentin, has been predicted to reduce the incidence of irreparable failures.[1,14,16,19-23] However, the debonding of fiber-reinforced posts and the loss of retention of single-complete-coverage restorations have been reported as frequent complications.[24-26] The bond strength to the fiber post surface has been reported to be significantly lower than that to metal.[27-29] Nevertheless, fiber posts remain popular among clinicians.[29]

The properties and clinical performance of fiber-reinforced posts have been studied extensively, but most of the studies have been in vitro or clinical studies with a small sample size and short follow-up time.[30] Therefore, whether fiber-reinforced posts represent a reliable alternative is still unclear, and clinicians often choose a post type based on their personal judgment rather than on scientific evidence.[2,3] Randomized control trials (RCTs) have been considered the best study design for intervention and providing evidence.[31] Conducting clinical trials with large amount of data and a long follow-up time requires significant amount of funding and time.[32] Systematic reviews analyzing the results of available randomized controlled trials on fiber-reinforced posts could help identify the best available evidence for their clinical performance. Some systematic reviews have been published on this topic, but their findings were inconclusive.[26,30,33-35] Therefore, this systematic review aimed to analyze the most recent available data on the survival and failure rates of fiber-reinforced posts as compared with metal posts. The null hypothesis tested was that no statistically significant differences would be found in the survival and success rates of endodontically treated teeth restored with glass-fiber-reinforced or metal posts.

MATERIAL AND METHODS

The research question for this review was formulated following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines by using the Population, Intervention, Comparison, Outcome, Study Type (PICOS) tool. The research population was adult participants in need of a post-and-core in permanent endodontically treated teeth. Intervention was the use of glass-fiber-reinforced posts compared with metal posts for the following outcomes: survival and/or success of endodontically treated teeth. The study design was a randomized controlled clinical trial.

Failure has been categorized as absolute and relative failure. Absolute failure has been defined as a catastrophic failure of an endodontically treated tooth restored with a post (for example, root fracture, root perforation, secondary caries leading to tooth extraction, endodontic failure, post fracture into the root canal). Relative failure is defined as a repairable failure of an endodontically treated tooth restored with a post (for example, post debonding, core and/or crown loosening, core fracture, repairable post fracture). Success is an outcome in the absence of absolute and relative failures. Survival is an outcome in the absence of absolute failures. The focused question was, "Do endodontically treated teeth restored with glass-fiber-reinforced posts exhibit differences in their survival rates when compared with teeth restored with metal posts?"

An electronic search was conducted through the PubMed, Embase, and Scopus databases. No language or journal type restrictions were applied. A supplemental manual search was also conducted. The search strategy and outcomes for each source are summarized in Table 1.

The terms of the search were (fiber post OR fiber reinforced post OR glass-fiber post OR fiber posts OR "Post and Core Technique" [MeSH]) AND (tooth OR teeth OR restoration) AND (metal post OR cast post OR metallic post).

To meet the eligibility requirements, the selected studies had to be human RCTs, with a follow-up time of at least 2 years, comparing glass-fiber-reinforced posts with metal posts (cast or prefabricated) for the foundation restoration of endodontically treated teeth receiving complete coverage restorations. For studies that assessed glass-fiber-reinforced posts without having a control group of metal posts, only partial data extraction occurred. If multiple publications on the same cohort were found, the publication with the longest follow-up time was included. Exclusion criteria were not meeting the inclusion criteria, duplicate publications, full text not available in English, and/or full text unavailable.

A 3-stage screening process was performed by 2 independent authors (N.T., M.M.-M.) (Fig. 1). Titles derived from the initial search were screened, and in vitro studies, studies not related to the review topic, and duplicates were excluded. The obtained abstracts were further screened for inclusion. Based on the selection of abstracts, the full text of the articles that met the inclusion criteria was then obtained. All full-text articles

Table 1. Search strategy

Database	Search Terms	Filters Used	Results
PubMed	(fiber post OR fiber reinforced post OR glass-fiber post OR fiber posts OR "Post and Core Technique" [Mesh]) AND (tooth OR teeth OR restoration) AND (metal post OR cast post OR metallic post)	Humans, Randomized Controlled Trial, Clinical Trial	123
Embase	(((('fiber'/exp OR fiber) AND post OR 'fiber'/exp OR fiber) AND reinforced AND post OR 'glass fiber'/exp OR 'glass fiber') AND post OR 'fiber'/exp OR fiber) AND posts AND ('tooth'/exp OR tooth OR 'teeth'/exp OR teeth OR restoration) AND ((('metal'/exp OR metal) AND post OR 'cast'/exp OR cast) AND post OR metallic) AND post	Randomized Controlled Trial or Clinical Trial	46
Scopus	(fiber post OR fiber reinforced post OR glass-fiber post OR fiber posts OR "Post and Core Technique" [Mesh]) AND (tooth OR teeth OR restoration) AND (metal post OR cast post OR metallic post)	Article, Human	15
Hand search	N/A	N/A	4

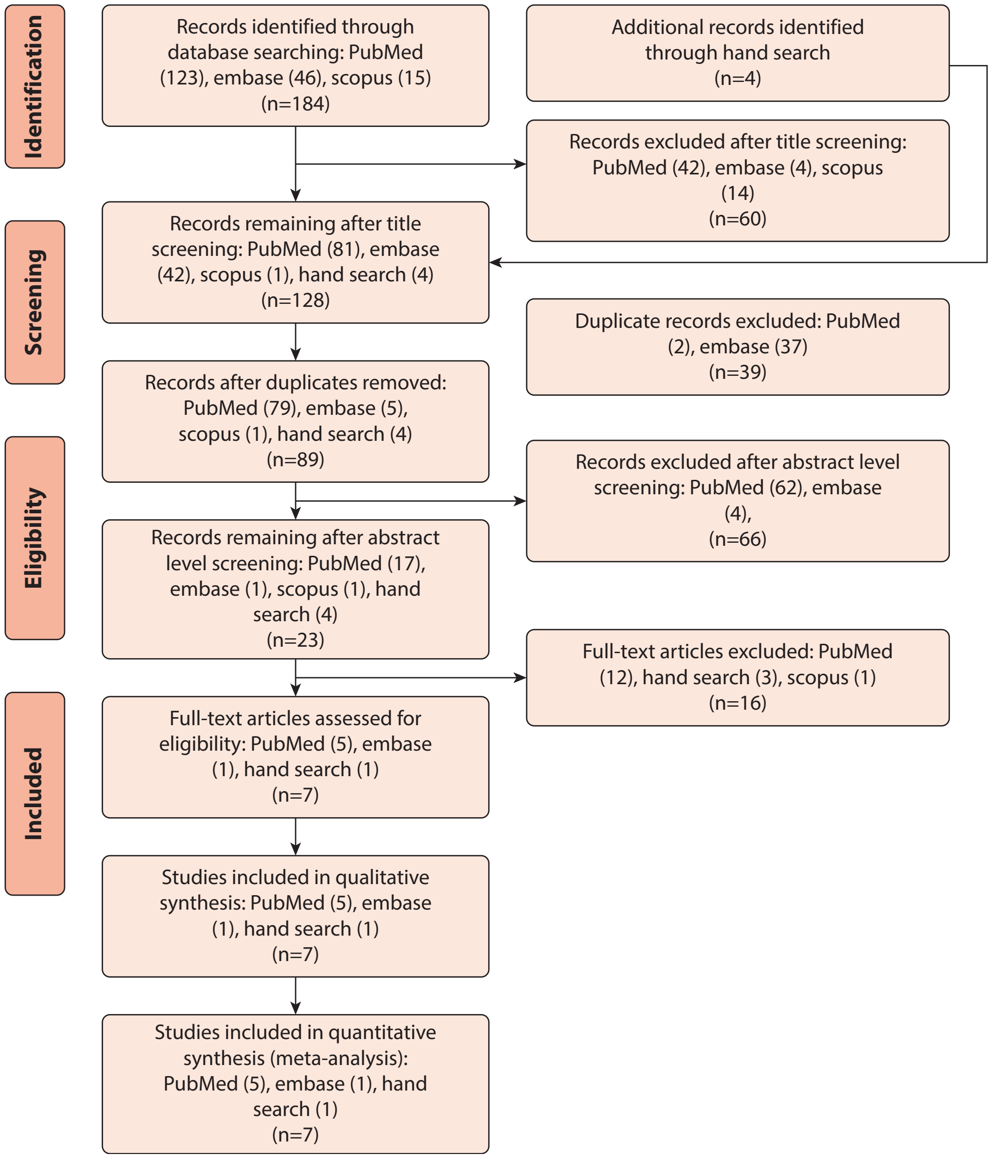


Figure 1. Screening process.

were read and analyzed. No language restriction was used to widen the search, but, when full text was not available in English, the article was excluded from the analyses. Any disagreement at any screening stage was resolved by discussion and the involvement of the senior author (M.F.).

Two authors (N.T., M.M.-M.) independently extracted and compared the data of the included articles. Any

Table 2. Study characteristics of included articles having metal post as control

				Fiber Post					Metal Post				
Study, Year	Follow-up	Defin. R	Cement	Post	N	Tx	Failure	Survival/ Success/ Annual Failure Rate	Post	N	Tx	Failure	Survival/ Success/ Annual Failure Rate
Sterzenbach et al, 2012[36]	Mean 71.2 mo	Metal-ceramic crowns	Self-adhesive resin cement (Relyx Unicem, 3M ESPE)	Fiberpoints Root Pins Glass, Schuetz Dental Group	41	Acetone; Tribochemical coating; Silane	1 FP failed horizontal at the gingival level	Survival 92%	Fiberpoints Root Pins Titanium, Schuetz Dental Group	46	Acetone; Silane	3 Endo failures	Survival 92%
Schmitter et al, 2011[37]	Mean 61.37 mo	Single crowns or FDPs or crowns in the RPD	Metal posts with zinc phosphate cement (Harvard Dental) Fiber posts with resin cement (Variolink II; Ivoclar, Vivadent)	Fiber (ER-dentin post, Brasseler)	39	Defatted with alcohol	11 failures: 2 PCC complex recemented, 2 cracked or chipped crowns, 1 tooth-apical alteration, 6 teeth extracted due to recurrent caries followed by loosening of PCC complex	Survival 71.8%	MSP (BKS, Brasseler)	42	N/A	21 failures: 1 tooth needed new PCC (loose), 17 teeth to be extracted (due to root fracture or perforation), 1 tooth to be observed due to apical alteration	Survival 50%
Sarkis-Onofre et al, 2020[38]	Median Overall62 months FP -58 months CMP 67.5 months	Metal-ceramic crowns	1.Some fiber posts with regular resin cement (RelyX ARC, 3M ESPE) 2.Some fiber posts with self-adhesive cement (RelyX U100/ U200, 3M ESPE) 3.Cast metal posts with self adhesive cement (RelyX U100/ U200, 3M ESPE)	Fiber post (White Post DC, FGM)	72	Ethanol; Silane	17 failures: 5 crown debonding, 7 root fractures, 2 post debonding, 1 secondary caries, 1 crown and post debonding, 1 endo failure	AFR 1.7 %	CMP (CoCr) previously done directly in acrylic resin	111	N/A	6 failures: 1 crown debonding, 3 root fractures, 1 post debonding, 1 crown and post debonding	AFR 1.2%
Cloet et al, 2017[39]	5 y	Full ceramic crowns	Panavia F 2.0/ED Primer II, Kuraray	65 PFP —Parapost, Fiber Lux, Coltene-Whaledent 26 CFP —everStick, StickTech	91	N/A	PFP-6 absolute failures, 7 relative failures CFP-2 absolute failures, 3 relative failures	Success CFP 87.8% PFP 81.6% Survival CFP 92.1% PFP 91.4%	PWPCC Parapost; Coltene Whaledent and Medior 3; Cendres+Metaux	101	N/A	14 absolute failures, 10 relative failures	Success 86.9% Survival 91.2%

AFR, annualized failure rate; CFP, custom fiber post; CMP, cast metal post; Defin. R, definitive restoration; Endo, endodontic; N, number; PCC, post-and-core and crown; PFP, prefabricated fiber post; PWPCC, prefabricated wrought post with cast core; Tx, treatment.

questions or disagreements were resolved by discussion. Extracted data were tabulated and analyzed and are summarized in Tables 2 and 3. The authors of included articles were contacted for missing data, but none were forthcoming.

All the statistical analyses were performed with a software program (RevMan; The Cochrane Collaboration). As homogeneity was determined by using chi2 and I^2 tests, random-effects meta-analysis was applied. Experimental and control groups of each study were analyzed for total failure, different failure modes, failure type per tooth positioning, survival, success, and annual failure rates to calculate the OR and 95% confidence interval (α=.05) (Fig. 2 and Fig. 3). Sensitivity

Table 3. Study characteristics of included articles not having metal post as control

		Experimental Group							Control Group (s)						
Study, Year	Follow-up	P	N	Tx	Cement	Final R	Failure	Survival/ Success/ Annual Failure Rate	P	N	Tx	Cement	Final R	Failure	Survival/ Success/ Annual Failure Rate
Bergoli et al, 2018[40]	Mean 37 mo	White Post DC fiber post	70	70% alcohol; Silane	Self-adhesive RelyX U100/ U200 (3M ESPE)*	Metal-ceramic crown	5 failures	Success 92.7%	White Post DC fiber post	65	70% alcohol; Silane	Regular Single Bond and RelyX ARC (3M ESPE)*	Metal-ceramic crown	4 failures	Success 93.8%
Skupien et al, 2016[41]	Mean 2.5 y	#0.5 or #1, White Post DC, FGM, Joinville, SC, Brazil	27	Alcohol, silane	Cement used 1. Self-adhesive; 2. Relyx U100 (3M ESPE) Regular RelyX ARC (3M ESPE, St. Paul, USA)	Metal-ceramic crown*	1 failure (periodontal status change)	AFR 0.26%	#0.5 or #1 White Post DC, FGM, Joinville, SC, Brazil	30	Alcohol; saline	Cement used: 1. Self-adhesive Relyx U100 (3M ESPE) 2. Regular RelyX ARC (3M ESPE, St. Paul, USA)	Comp. R*	1 root fracture 7 restoration fractures 2 secondary caries	AFR 1.83%
Cagidiaco et al, 2008[42]	36 mo	DT Light Post*	120	Prime and Bond NT and Self-Cure Activator applied on the post and air-dried for 5 s	Prime and Bond NT and Self-Cure Activator + Calibra dual-cure resin cement	Metal-ceramic crown	No crown dislodgement or root fracture	Survival 90.9%	Ever Stick fibers*	120	N/A	All Bond 2 + Bis Core build-up	Metal-ceramic crown	Root fractures and crown dislodgements	Survival 76.7%
									No Post*	120	N/A	N/A	Metal-ceramic crown	13 root fractures 32 crown dislodgements	Survival 62.5%

AFR, annualized failure rate; Comp. R, composite resin restoration; Definitive R, definitive restoration; N, number; P, post; Tx, treatment. *Variable of study.

analysis was not conducted because of the small number of included studies. The publication bias was evaluated graphically by using funnel plots and statistically by using the Begg and Egger tests. In addition, the mean follow-up time and number of analyzed study participants and teeth were calculated. The quality assessments are presented in Figure 4A, B. Three authors (N.T., M.M.-M., Z.S.N.) performed the assessment independently. A summary of findings table (SoF) was generated by using the Group Reading Assessment and Diagnostic Evaluation (GRADE) profiler, and the results are presented in Table 4.

RESULTS

The screening process is summarized in the PRISMA flow diagram in Figure 1. Out of 7 studies, 4[36-39] were included for a full meta-analysis, and the remaining 3[40-42] only for partial analysis because of the lack of a control group. None of the outcomes of these meta-analyses had statistical significance (P>.05). Follow-up time of the included studies was 2.5 to 7 years with an average of 4.26 years. A total of 822 study participants and 1106 teeth were analyzed.

The meta-analysis revealed an overall survival rate of 92.8% for endodontically treated teeth restored with glass-fiber-reinforced posts compared with 78.1% for those restored with metal posts (Fig. 2A) and an overall success rate of 83.4% for teeth restored with glass-fiber-reinforced posts compared with 86.9% for those restored with metal posts.

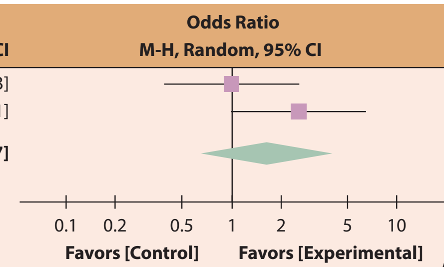
RCTs that compared the performance of fiber posts with that of metal posts were analyzed for total failure (Fig. 2B) and different types of failure mode distribution in the 2 groups.[36-39] Overall, higher survival, fewer failures, lower root fracture, endodontic failures, and post debonding were found in the fiber post group. Higher success rates, lower annual failure rates, lower secondary caries, apical alteration, and crown failure were found in the metal post group.

The remaining 3 RCTs[40-42] comparing the clinical performance of endodontically treated teeth with different fiber post groups could only be analyzed for total failure occurrence, as metal posts were not used as the control (Fig. 2C). These studies had high heterogeneity (I^2=79%)

Two RCTs reported the effect of tooth positioning.[38,39] Fewer absolute (Fig. 3A) but more relative failures (Fig. 3B) were observed in anterior endodontically treated teeth restored with fiber-reinforced posts than in anterior teeth restored with metal posts. A similar trend was seen for posterior teeth (Fig. 3C, D). Regardless of post type, anterior teeth showed fewer absolute failures (Fig. 3E) and more relative failures than posterior teeth (Fig. 3F).

Study or Subgroup	Experimental Events	Experimental Total	Control Events	Control Total	Weight	Odds Ratio M-H, Random, 95% CI
Cloet 2017	83	91	82	90	46.9%	1.01 [0.36, 2.83]
Schmitter 2011	28	39	21	42	53.1%	2.55 [1.01, 6.41]
Total (95% CI)		**130**		**132**	**100.0%**	**1.65 [0.67, 4.07]**
Total events	111		103			

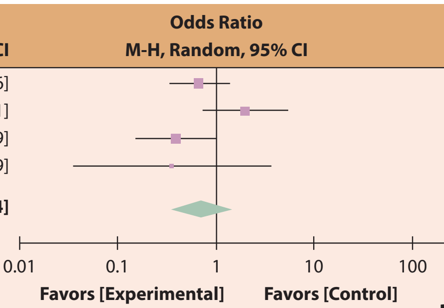
Heterogeneity: τ^2=0.18; χ^2=1.71, df=1 (*P*=.190); I^2=42%
Test for overall effect: Z=1.09 (*P*=.280)



A

Study or Subgroup	Experimental Events	Experimental Total	Control Events	Control Total	Weight	Odds Ratio M-H, Random, 95% CI
Cloet 2017	18	91	24	90	35.5%	0.68 [0.34, 1.36]
Sarkis-Onofre 2020	17	111	6	72	27.1%	1.99 [0.74, 5.31]
Schmitter 2011	11	39	21	42	28.7%	0.39 [0.16, 0.99]
Sterzenbach 2012	1	41	3	46	8.6%	0.36 [0.04, 3.59]
Total (95% CI)		**282**		**250**	**100.0%**	**0.73 [0.35, 1.54]**
Total events	47		54			

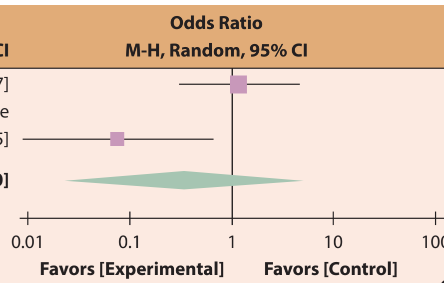
Heterogeneity: τ^2=0.28; χ^2=6.15, df=3 (*P*=.100); I^2=51%
Test for overall effect: Z=0.81 (*P*=.420)



B

Study or Subgroup	Experimental Events	Experimental Total	Control Events	Control Total	Weight	Odds Ratio M-H, Random, 95% CI
Bergoli 2008	5	70	4	65	54.5%	1.17 [0.30, 4.57]
Cagidiaco 2008	0	260	0	100		Not estimable
Skupien 2014	1	27	10	30	45.5%	0.08 [0.01, 0.65]
Total (95% CI)		**357**		**195**	**100.0%**	**0.34 [0.02, 5.20]**
Total events	6		14			

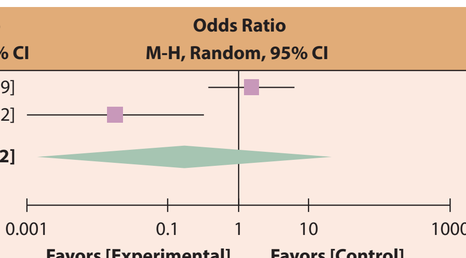
Heterogeneity: τ^2=3.07; χ^2=4.68, df=1 (*P*=.030); I^2=79%
Test for overall effect: Z=0.78 (*P*=.440)



C

Study or Subgroup	Experimental Events	Experimental Total	Control Events	Control Total	Weight	Odds Ratio M-H, Random, 95% CI
Sarkis-Onofre 2020	7	111	3	72	53.3%	1.55 [0.39, 6.19]
Schmitter 2011	0	39	17	42	46.7%	0.02 [0.00, 0.32]
Total (95% CI)		**150**		**114**	**100.0%**	**0.20 [0.00, 24.82]**
Total events	7		20			

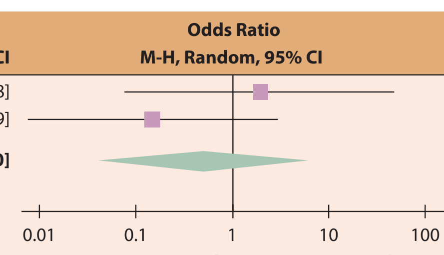
Heterogeneity: τ^2=10.96; χ^2=9.36, df=1 (*P*=.002); I^2=89%
Test for overall effect: Z=0.66 (*P*=.510)



D

Study or Subgroup	Experimental Events	Experimental Total	Control Events	Control Total	Weight	Odds Ratio M-H, Random, 95% CI
Sarkis-Onofre 2020	1	111	0	72	47.3%	1.97 [0.08, 48.98]
Sterzenbach 2012	0	41	3	46	52.7%	0.15 [0.01, 2.99]
Total (95% CI)		**152**		**118**	**100.0%**	**0.51 [0.04, 6.40]**
Total events	1		3			

Heterogeneity: τ^2=0.85; χ^2=1.34, df=1 (*P*=.250); I^2=25%
Test for overall effect: Z=0.53 (*P*=.600)



E

Figure 2. Results of meta-analyses: survival/success/failure mode outcomes. A, Comparison of survival rates. B, Comparison for total failure rates of studies having metal post as control. C, Comparison for total failure rates of studies without metal post as control. D, Comparison of root fracture. E, Comparison of endodontic failures.

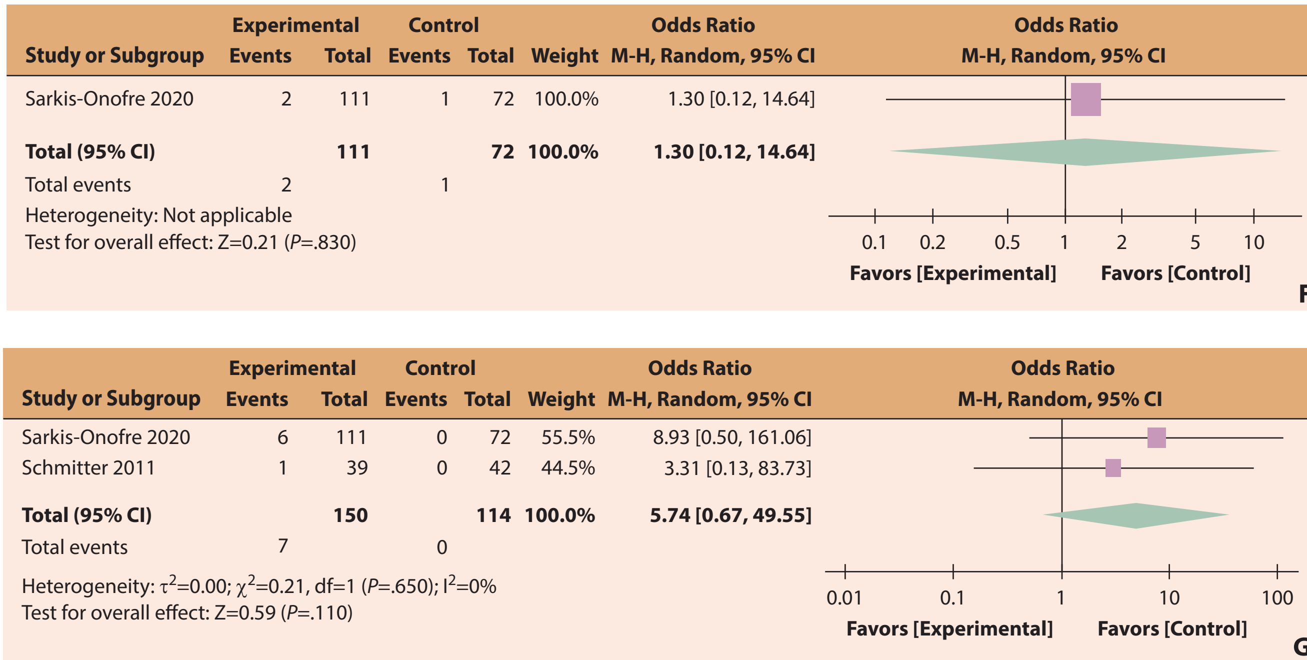


Figure 2. *(Continued)*. F, Comparison of annual failure rates. G, Comparison of secondary caries.

Graphical representation of the results of the meta-analyses is summarized in forest plots (Figs. 2 and 3).

The studies showed relatively low risk of bias (Fig. 4). However, the completeness of outcome reporting was unclear in a few studies,[36,39,40,42] and selective outcome reporting may have increased the risk of bias. The authors of the RCTs with missing data were contacted for the missing data, but no response was received. Whether the missing data would have affected the overall outcome of the studies is unclear.

The GRADE assessment results are presented in Table 4. Overall, a high or moderate quality of evidence was seen.

DISCUSSION

The tested null hypothesis was not rejected as no statistical differences in the survival or success rates were seen when comparing endodontically treated teeth restored with glass-fiber-reinforced posts to those restored with metal posts. The success and survival rates and the failure mode distribution were analyzed based on the extracted data. None of the outcomes of these meta-analyses had statistical significance and thus failed to demonstrate the superiority of either the glass-fiber-reinforced or metal post system. However, analyses of failure mode distribution identified clinical trends that could help clinicians in decision-making.

Of the 7 RCTs, 4 used metal posts as their control group. The analyses of these studies revealed fewer absolute failures such as root fracture for the glass-fiber-reinforced post group (Fig. 2D). Higher failure rates of cast metal post-and-cores have already been reported by previous systematic reviews.[34] Sorensen and Martinoff[43] pointed out that using tapered cast post-and-cores could increase the number of irreversible failures leading to inevitable tooth extraction, possibly because the higher elastic modulus of metal posts causes stress concentration.[18,22,23,44,45]

Fiber posts showed a higher incidence of secondary caries (Fig. 2G). Although flexible posts could reduce vertical root fractures, they may also allow movement and flexure of the core under the crown in the cervical area, causing microleakage and subsequent caries.[46,47] A higher incidence of post-and-core and crown complex debondings was also observed for fiber posts. The degradation of dentin bonding and the challenges of adhesion to radicular dentin have been highlighted.[26,44,48,49] A long-term hermetic seal is essential to avoid microleakage, subsequent secondary caries, and post-and-core debonding.[49,50] Fiber-reinforced posts consist of fibers embedded in an epoxy resin matrix with high degree of polymerization conversion that protects the fibers.[29] However, the high degree of conversion leaves fewer free functional groups that, to a large extent, determine the adhesive interaction of the post surface with the resin in cements and composite resin core materials.[29]

Post debonding has also been reported for metal posts. However, Schmitter et al[37] cemented metal screw posts with zinc phosphate. Higher leakage and less resistance to cyclic loading have been reported for zinc phosphate cements.[50,51] Thus, having metal posts cemented with a zinc phosphate as a control could be a limitation, skewing the results of the current meta-analyses.

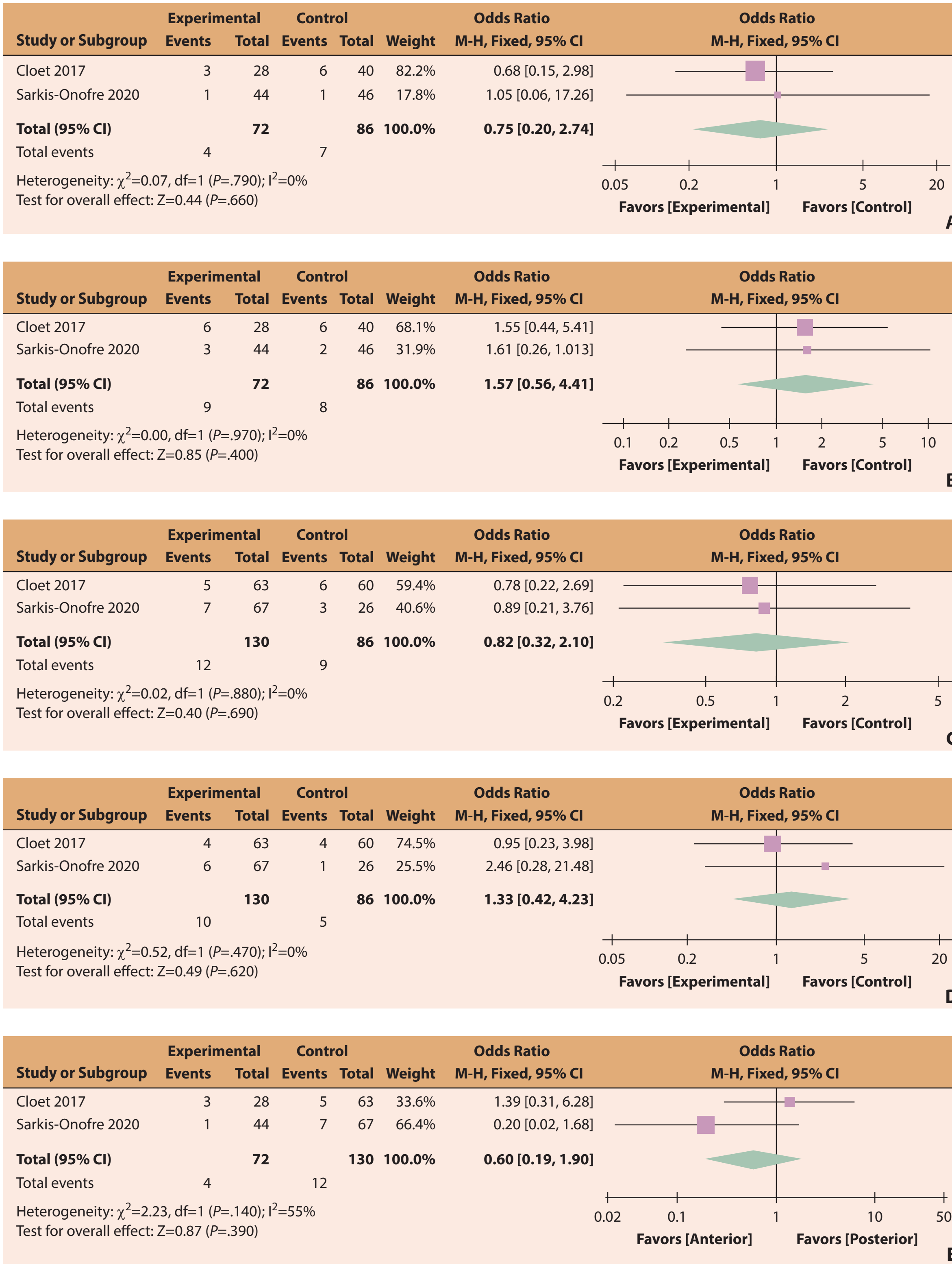


Figure 3. Results of meta-analyses: effect of tooth positioning. A, Comparison of anterior absolute failures. B, Comparison of anterior relative failures. C, Comparison of posterior absolute failures. D, Comparison of posterior relative failures. E, Comparison of anterior versus posterior absolute failures.

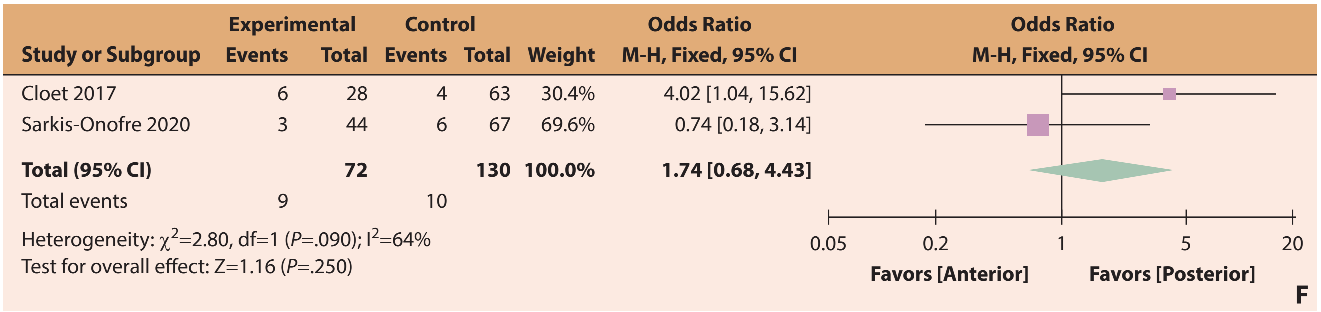


Figure 3. *(Continued)*. F, Comparison of anterior versus posterior relative failures.

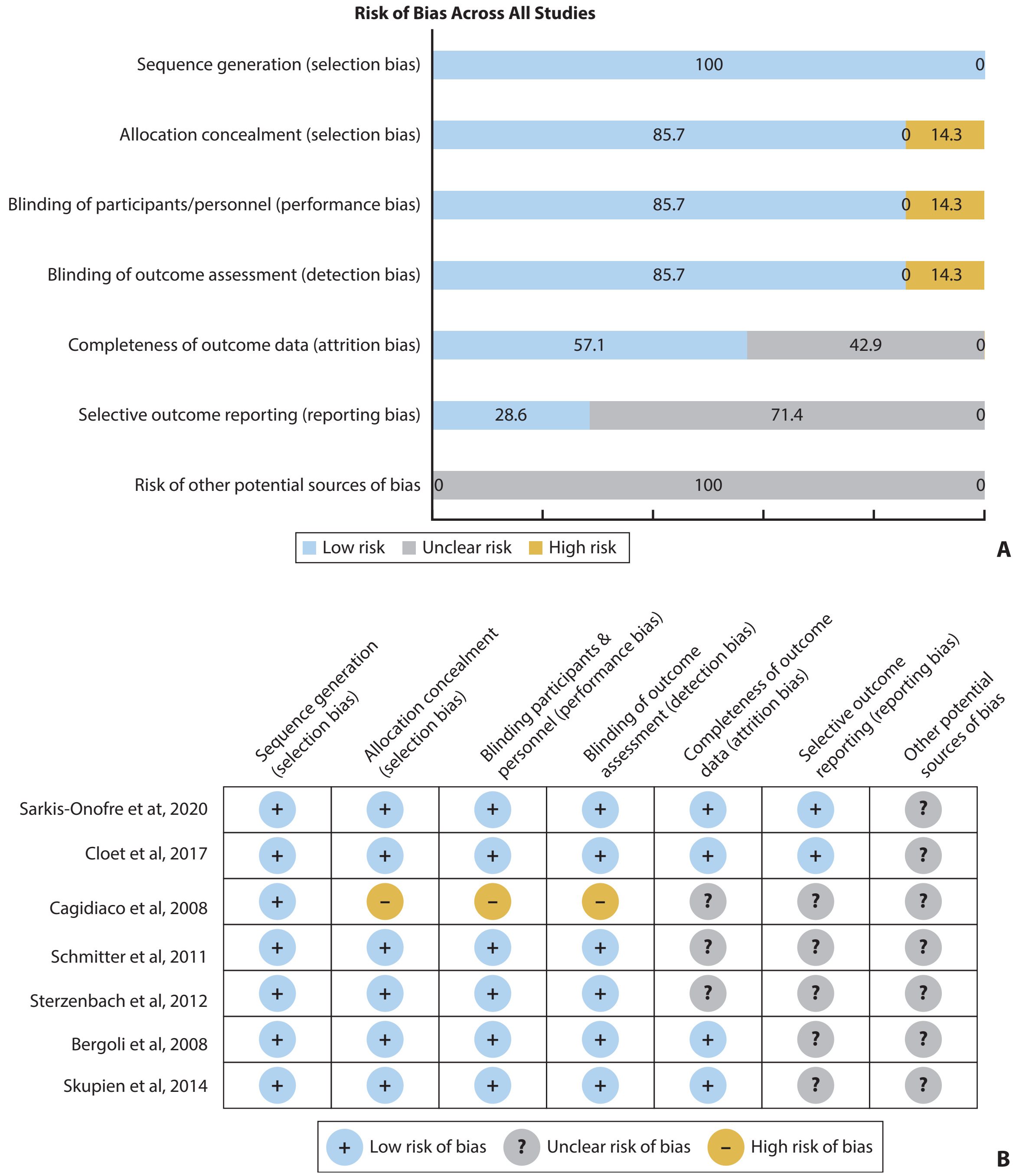


Figure 4. Risk of bias. A, Risk-of-bias summary graph. B, Risk-of-bias summary traffic light plot.

Table 4. GRADE assessment

Summary of findings						
Fiber post compared with control for restoration of endodontically treated teeth						
Patient or population: restoration of endodontically treated teeth **Setting**: **Intervention**: fiber post **Comparison**: control						
	Anticipated Absolute Effects* **(95% CI)**					
Outcomes	**Risk With Control**	**Risk With Fiber Post**	**Relative Effect (95% CI)**	**No. of Participants (Studies)**	**Certainty of the Evidence (GRADE)**	**Comments**
Total failure rates (control with metal post)	22 per 100	17 per 100 (9 to 30)	OR 0.73 (0.35 to 1.54)	532 (4 RCTs)	⊕⊕⊕◯ MODERATE	Cloet et al, 2017, had selection bias, detection bias, and performance bias.
Total failure rates (control without metal post)	7 per 100	3 per 100 (0 to 29)	OR 0.34 (0.02 to 5.20)	552 (3 RCTs)	⊕⊕⊕⊕ HIGH	–
Root fracture	18 per 100	4 per 100 (0 to 84)	OR 0.20 (0.00 to 24.82)	264 (2 RCTs)	⊕⊕⊕⊕ HIGH	–
Endodontic failures	3 per 100	1 per 100 (0 to 14)	OR 0.51 (0.04 to 6.40)	270 (2 RCTs)	⊕⊕⊕⊕ HIGH	–
Annual failure rates	1 per 100	2 per 100 (0 to 17)	OR 1.30 (0.12 to 14.64)	183 (1 RCT)	⊕⊕⊕⊕ HIGH	–
Secondary caries	0 per 100	0 per 100 (0 to 0)	OR 5.74 (0.67 to 49.55)	264 (2 RCTs)	⊕⊕⊕⊕ HIGH	–
Anterior absolute failures	8 per 100	6 per 100 (2 to 20)	OR 0.75 (0.20 to 2.74)	158 (2 RCTs)	⊕⊕⊕◯ MODERATE	Cloet et al, 2017, had selection bias, detection bias, and performance bias.
Anterior relative failures	9 per 100	14 per 100 (5 to 31)	OR 1.57 (0.56 to 4.41)	158 (2 RCTs)	⊕⊕⊕◯ MODERATE	Cloet et al, 2017, had selection bias, detection bias, and performance bias.
Posterior absolute failures	10 per 100	9 per 100 (4 to 20)	OR 0.82 (0.32 to 2.10)	216 (2 RCTs)	⊕⊕⊕◯ MODERATE	Cloet et al, 2017, had selection bias, detection bias, and performance bias.
Posterior relative failures	6 per 100	8 per 100 (3 to 21)	OR 1.33 (0.42 to 4.23)	216 (2 RCTs)	⊕⊕⊕◯ MODERATE	Cloet et al, 2017, had selection bias, detection bias, and performance bias.
Anterior (control) versus posterior absolute failures	9 per 100	6 per 100 (2 to 16)	OR 0.60 (0.19 to 1.90)	202 (2 RCTs)	⊕⊕⊕◯ MODERATE	Cloet et al, 2017, had selection bias, detection bias, and performance bias.
Anterior (Control) versus posterior relative failures	8 per 100	13 per 100 (5 to 27)	OR 1.74 (0.68 to 4.43)	202 (2 RCTs)	⊕⊕⊕◯ MODERATE	Cloet et al, 2017, had selection bias, detection bias, and performance bias.

CI, confidence interval; OR, odds ratio. GRADE Working Group grades of evidence. High certainty: We are very confident that the true effect lies close to that of the estimate of the effect. Moderate certainty: We are moderately confident in the effect estimate; the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different. Low certainty: Our confidence in the effect estimate is limited; the true effect may be substantially different from the estimate of the effect. Very low certainty: We have very little confidence in the effect estimate; the true effect is likely to be substantially different from the estimate of effect. *Risk in intervention group (and its 95% confidence interval) based on assumed risk in comparison group and relative effect of intervention (and its 95% CI).

A higher annual failure rate was reported by Sarkis-Onofre et al[38] for the fiber-reinforced post group, with cast metal post-and-cores as the control. Cast post-and-cores entail intimate adaptability, thus increasing resistance to rotation and providing better retention. However, all prefabricated, metal or fiber-reinforced posts rely solely on adhesion.

Three of the studies[40-42] were only analyzed for total failure as no metal posts were used for comparison (Fig. 2C). Owing to the existing high heterogeneity (I^2=79%), separate odds ratio numbers should be considered for these articles. Bergoli et al[40] compared fiber posts cemented either with self-adhesive resin cement or conventional resin cement and indicated that conventional resin cement resulted in better performance. However, because the difference was not statistically significant, they considered the use of self-adhesive resin cements appropriate for the cementation of fiber-reinforced posts. Skupien et al[41] compared fiber posts restored either with metal-ceramic complete coverage restorations or with composite resin only. They reported statistically significant differences between the 2 groups and concluded that fiber posts restored with composite resin resulted in a significantly decreased survival rate. If an endodontically treated tooth requires a post for core retention, complete coverage restoration should be the definitive treatment.[43,50]

Two studies compared custom and prefabricated fiber posts.[39,42] EverStick fibers were used to customize the fiber posts in both studies. Cloet et al[39] reported higher success and survival rates of 92.10% and 87.80% for custom fiber posts when compared with 91.40% and 86.90%, respectively, for prefabricated fiber posts. Cagidiaco et al[42] disagreed, reporting a 90.90% survival rate for prefabricated posts and only 76.70% for custom-fabricated posts with increased rates of root fracture and crown dislodgement. These contradictory findings are somewhat supported by the findings of in vitro studies.[4]

Although not statistically different, the results showed that endodontically treated anterior teeth had better success rates (Fig. 3E) and that endodontically treated posterior teeth showed better survival rates (Fig. 3F), regardless of post type. The role of tooth anatomy in the performance of post systems has been previously discussed.[50,52] More RCTs are needed to analyze the influence of tooth position on the performance of different post systems.

This study aimed to provide reliable evidence, and only RCTs were included in the analyses.[31] One of the analyzed studies was published as recently as 2020, which indicates the relevance of the topic. Limitations of this systematic review included the heterogeneity of the protocols with different types of metal posts being used for control. The fundamental differences between the prefabricated and custom metal posts make it scientifically questionable to put them in one group for meta-analyses. However, the heterogeneity of the studies and data reporting in general remain a limitation of systematic reviews and meta-analyses.[53]

Another limitation was having composite resin restorations, single complete coverage restorations, and fixed dental prostheses, as well as abutment surveyed crowns for removable dental prostheses as definitive restorations. Some articles did not specify the number of each type of definitive restoration. In the same way, the type of cement, patient sex, and operator experience can all be confounding variables. Therefore, focusing on a single factor (metal versus fiber posts) in clinical studies is difficult.

Scientific evidence is difficult to obtain in restorative dentistry. At least 1000 study participants and 5 years of follow-up time may be necessary to produce reliable results.[32] The mean follow-up time in the present study was 51.08 months (approximately 4.5 years), and the number of study participants was 822. Therefore, although with limitations, recent systematic reviews have value and provide evidence for the clinical performance of endodontically treated teeth restored with fiber-reinforced posts.

Similar to most systematic reviews, despite an exhaustive search process, the authors may have failed to identify additional articles. Whether incorporating these omitted articles would have changed the conclusions of this systematic review is unknown.[54]

CONCLUSIONS

Based on the findings of this systematic review and meta-analysis, the following conclusions were drawn:

1. No difference was found in survival and success rates when treating endodontically treated teeth either with glass-fiber-reinforced or metal posts.
2. Tooth position did not affect differences in the survival and success rates when restoring endodontically treated teeth either with glass-fiber-reinforced or metal posts.
3. The overall survival rate was 92.8% and 78.1% for glass fiber posts and metal posts, respectively. Both represent reliable materials when a significant amount of coronal tooth structure is missing and treatment with a post is indicated.
4. The use of metal posts can be associated with an increased rate of root fracture.
5. The use of fiber posts can be associated with an increased rate of secondary caries.

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