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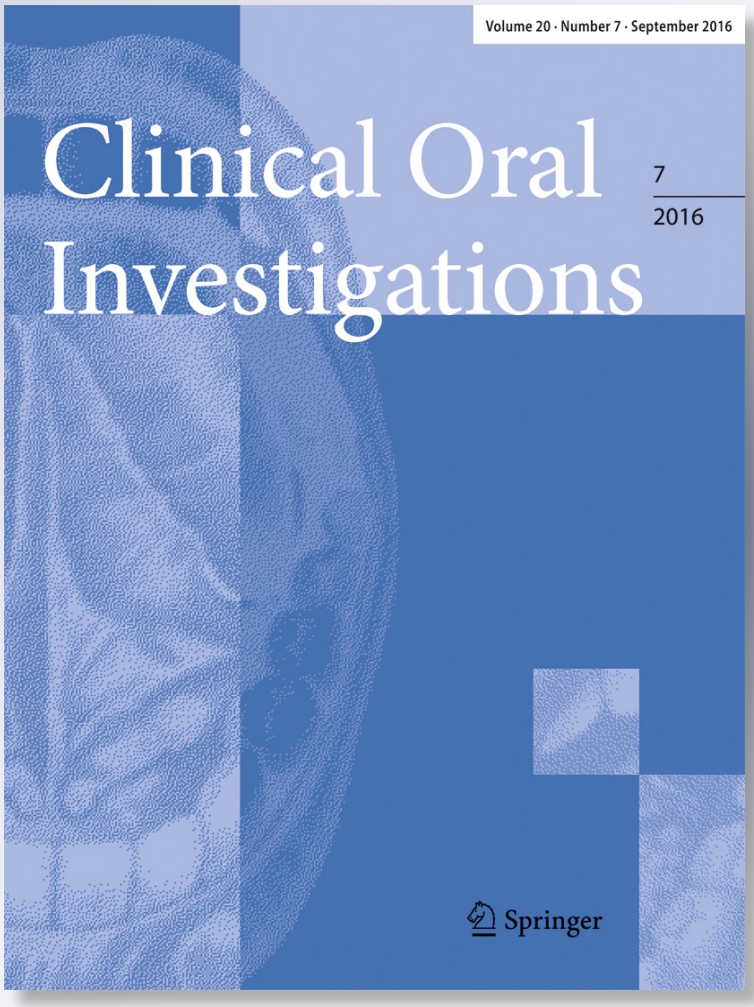

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REVIEW

Complications of endodontically treated teeth restored with fiber posts and single crowns or fixed dental prostheses—a systematic review

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Abstract
Objective The present systematic review aimed at assessing data from the literature on endodontic and prosthetic complications in endodontically treated teeth restored with fiber posts and single crowns (SCs) or fixed dental prostheses (FDPs).
Materials and methods Available randomized controlled clinical trials evaluating endodontic and prosthetic complications in the teeth treated with fiber posts and restored with different prosthetic restorations were reviewed. PubMed, Evidence-Based Dentistry, BMJ Clinical Evidence, Embase, DynaMed, and gray literature restricted to scientific literature were analyzed; also, manual researches were performed. English language and time filters (from 1990 to 2015) were used.
Results The database search produced 4230 records, many of which were duplicates. The manual research did not produce any other relevant article. After duplications were removed, all the selected databases produced 3670 records. Reading titles and abstracts, two independent reviewers excluded 3664 reports. The full-texts of the remaining six reports were read. Only four studies met the inclusion criteria and were included in this systematic review.
Conclusions The most frequently reported failures in the available studies were as follows: fiber post debonding, loss of retention of single crowns, and marginal gaps. Less frequently, chippings and fractures were recorded in SCs. No studies about complications related to FDPs were found.
Clinical relevance A correlation between the failure rates of fiber posts and the type of prosthetic restorations just like SCs and FDPs cannot be found to date. Further randomized controlled clinical studies are required to achieve evidence-based conclusions, particularly about the use of fiber posts with FDPs.

Keywords Fiber post · Single crown · Fixed dental prosthesis · Endodontic complications · Prosthetic complications · Endodontically treated teeth

Introduction

One of the main functions of fiber posts is to ensure the retention of restoration after the loss of a large amount of dental structure, in order to secure the filling material to the tooth and build up a prosthetic core. It is well recognized that the presence of a post and core has the function to improve the retention of a restoration but does not improve at all the strength of dental roots [1, 2].

In the past decades, cast or prefabricated metal posts made up of materials with high moduli of elasticity (*E*) were used, just like gold alloys, stainless steel, or titanium since they were considered strong and clinically effective [3]. Nowadays, fiber posts are the most clinically used; they were introduced about 20 years ago, made up of materials with lower moduli of elasticity, such as glass, quartz, polyethylene, and carbon-reinforced composites [4].

Several studies reported that root fractures occur more frequently with metal than fiber posts [2–4], the

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main reason being the difference between the modulus of elasticity of metal (220 GPa) and dentin (42 GPa). On the contrary, the modulus of elasticity of fiber posts (25–57 GPa) is closer to that of dentine [5–8] and this is considered a favorable property from the biomechanical point of view [6–8]. Recently, a systematic review with meta-analysis reported that the incidence of fractures was equal using either fiber or metal posts [5], so the topic remains controversial.

As to fiber posts, the most frequent complication is debonding; it is influenced by many factors, such as amount of residual tooth tissues, occlusal scheme and number of opposing teeth in function, periodontal status, signs of parafunctions, presence or absence of ferrule, and quality of adhesion [1, 8, 9].

Moreover, the characteristics of fiber posts as well as the adopted clinical procedures thoroughly influence the performances of the restorations, just like length and diameter of posts, integrity of the adhesive surface [10], and thickness of adhesive cements [11]. The presence of full crowns reduces the influence of the diameter of prefabricated posts on the occurrence of root fractures with either metal or fiber posts [12].

According to the literature, the prognosis of fiber posts is better in molars than in the anterior teeth. A high incidence of vertical fractures was noticed in the maxillary premolars, probably related to the small mesiodistal canal diameter, which could increase stress within the root. A higher amount of coronal structure and the presence of interproximal contacts improve the survival rates of post restorations [13].

The survival rates of fiber post restorations also depend on the type of the final prosthesis. Endodontically treated teeth restored with single crowns (SCs) were reported to show higher survival rates, probably for a shielding effect of crowns, while in the presence of fixed dental prostheses (FDPs) or removable partial dentures (RPDs) the failure rates were reported to be higher, probably due to unfavorable bending moments of the prosthetic systems [12].

Several investigations pointed out that crown coverage could positively affect the outcome of post-endodontic restorations with fiber posts. The survival rates of endodontically treated teeth restored with fiber posts and crowns was six times higher than those of teeth restored without crowns [14], achieving a survival rate of 85.1 % after 10 years of function [15]. The placement of a crown seemed to be more significative than the type of abutment buildup for the survival of the teeth [14].

The present systematic review aimed at investigating the relationships between the presence of fiber posts in abutment teeth and the occurrence of endodontic and prosthetic complications in the presence of SCs and FDPs, in patients with periodontal status *ad integrum*.

Search methods

The primary objective of the present systematic review was to analyze the incidence of clinical complications in SCs and FDPs using abutment teeth restored with fiber posts.

The secondary objective was to compare differences in failure rates between subgroups regarding the following variables:

- Presence of ferrule
- Type (incisor, canine, premolar, molar) and location (maxilla or mandible) of the teeth

The systematic review was based on a literature review of papers published between 1990 and 2015 and available in electronic databases (Pubmed, Evidence-Based Dentistry, BMJ Clinical Evidence, Embase, and Dynamed), since the earliest fiber-reinforced composite posts were introduced in the USA in the1990s; only articles written in English were considered, since it is considered to be the universal language of science. Gray literature was analyzed as well on the website www.opengrey.eu.

The strategy of the search included the use of different keywords and boolean operators, as follows:

1. Fiber post/post
2. Fiber post and/or single crown
3. Fiber post and/or fixed partial denture
4. Fiber post and/or fixed dental prosthesis
5. Fiber post and/or prosthetic restoration
6. Fiber post and/or prosthesis
7. Fiber post and/or complication

A manual search was performed as well, looking for eligible papers and reference lists of articles. Researchers and authors of non-published studies or of published studies that were not available electronically were contacted by the reviewers. Data extraction was carried out independently by two experienced reviewers; any disagreement was resolved by discussion with a third experienced reviewer.

Inclusion criteria

This systematic review was structured on the basis of the PRISMA guidelines.

The eligibility of investigations was assessed according to the P.I.C.O. as follows:

1. Participants

– Patients with periodontal status *ad integrum*, endodontically treated to a sound state permanent teeth (absence of periodontal disease) and restored with SCs or FDPs

2. Interventions

– Randomized clinical trials (RCTs) evaluating fiber posts and prosthetic complications over a minimum observational period of 36 months
– RCTs evaluating failure rates of posts and/or final restorations in a single group but considering different types of teeth
– RCTs reporting clearly defined inclusion and exclusion criteria and description of clinical procedures.

3. Comparison

– Studies comparing failure rates of fiber posts and other prosthetic systems (i.e., direct composite)

4. Outcomes

– Failure rates of fiber posts and prosthetic restorations in each group
– Comparison of failure rates between different groups

All the studies not fulfilling the inclusion criteria were not included in the systematic review.

Quality assessment The quality of the included studies was evaluated using the criteria reported by the Cochrane Handbook for Systematic Reviews of Interventions [16]. Consequently, the quality assessment was carried out using the following criteria:

– Was there a randomization of the participants?

0: Not randomized
1: Inadequate
2: Unclear
3: Adequate

– Was a calculation of sample size undertaken?

0: No/not mentioned
1: Yes

– Were inclusion/exclusion criteria clearly defined?

0: Not defined
1: Poorly defined
2: Well defined

– Was follow-up achieved?

0: No/not mentioned
1: Yes (<80 %)
2: Yes (≥80 %)

– Was treatment blind to patients, operators, or assessors recorded?

0: No/not possible
1: Unclear
2: Yes

– Were the outcomes of the people who withdrew described by study group and included in the analysis (intention-to-treat or ITT analysis)?

0: Not mentioned
1: States numbers and reasons for withdrawal by study group but no analysis
2: primary analysis based on all recruited cases

– Were the control and treatment groups comparable at entry?

0: Large potential for confounding or not discussed
1: Confounding small–mentioned but not adjusted for
2: Unconfounded–good comparability of groups or confounding adjusted for

The risk of bias was assessed according to the Cochrane Handbook for Systematic Reviews of Interventions considering quality criteria, allocation concealment, blinding of outcome assessor, and follow-up [16].

Search results

Database search produced 4230 records, many of which were duplicates. Manual research did not produce any other relevant article. After duplications were removed, all the selected databases produced 3670 records.

Analyzing titles, abstracts, and keywords, the reviewers excluded 3664 papers that did not meet the inclusion criteria; the main reasons for exclusion were as follows: not the topic of interest, in vitro studies, and studies without control. Four studies were not available electronically, thus the authors were contacted by email and the response rate was 100%. The full-texts of the remaining six articles were read, and the reviewers

excluded two papers, as they focused on endodontic treatment and complications. The reasons for the exclusion of these articles are reported in Table 1. The two independent reviewers' agreement rate was 97%. Any disagreement was discussed with a third reviewer. The workflow of the paper screening process is reported in Fig. 1.

On the basis of the reported inclusion criteria, only four studies were included in the present systematic review [19–22].

Results

Only the following four studies met the inclusion criteria and were systematically reviewed: Mannocci et al. [19], Schmitter et al. [20], Ferrari et al. [21], and Sterzenbach et al. [22].

In a RCT, Mannocci et al. [19] compared the survival rates of endodontically treated premolars restored with fiber posts (Composipost, RTD, St Egreve, France), full cast crowns or composite fillings. In the study, 117 patients were recruited and randomly divided into two groups by tossing a coin: 60 teeth were restored with direct composite restorations and 57 with porcelain-fused-to-metal (PFM) SCs. All the restorations were made by the same operator. All the details regarding root canal treatments, crowns preparations, and criteria of success/failure were reported in the study. At the baseline, the patients were healthy and received oral hygiene instructions.

In a RCT, Schmitter et al. [20] investigated the 5-year results of two post systems: titanium screw posts (BKS, Brasseler, GA, USA) and glass fiber posts (ER dentine post, Brasseler). In this study, 100 patients requiring a SC, a FDP, or a RPD were recruited. At the baseline, all the patients did not show signs of periodontal disease. Forty-two patients were treated with metal screw posts and 39 patients with fiber posts. Post assignment was randomized and all the posts were placed by undergraduate students 6 months to 1 year prior to graduation. The metal screw posts were cemented with a zinc phosphate cement (Harvard cement, Harvard dental, Hoppegarten, Germany), whereas the fiber posts were luted using a composite resin cement (Variolink II, Ivoclar Vivadent, Schaan, Liechtenstein). All the details regarding the clinical procedures were described. The patients were recalled after 1 year and 5 years. Both the patients and the dentists were blinded about the type of post used after endodontic treatment. The 5-year recall was performed by another blind dentist who had not been involved before in the study.

In a RCT, Ferrari et al. [21] evaluated the 6-year survival of endodontically treated premolars restored with fiber posts and PFM SCs. In this study, a sample of 345 patients was recruited and 360 premolars were divided into six groups on the basis of coronal residual dentine (4 to 1 residual coronal walls, presence of a minimum of 2 mm of ferrule, absence of ferrule). Each group was randomly divided into three subgroups on the basis of the restorative procedures as follows: no posts, prefabricated fiber posts (DT Light posts, RTD), and customized fiber posts (EverStick fibers, Stick Tech Ltd., Turku, Finland). The DT posts were luted using Calibra (Dentsplay Ltd., Kostanz, Germany), whereas the EverStick posts were luted using BisCore (Bisco, Schaumburg, IL, USA). All the details about the clinical procedures were reported in the study. At the baseline, all the patients did not present periodontal disease. All the selected teeth were in occlusal function with a natural tooth and in interproximal contact with two natural teeth. The clinical procedures were performed by the same experienced operator. Two examiners evaluated independently success and failure rates.

In a RCT, Sterzenbach at al. [22] evaluated the 7-year outcomes of endodontically treated teeth restored with glass fiber or titanium posts (Fiberpoints Roots Pins Glass and Fiberpoints Root Pins Titanium, Schutz Dental Group, Rosbach, Germany). A sample of 91 patients was included in the study and randomly assigned to titanium (n = 45) or glass fiber post (n = 45) groups. Either the posts or PFM SCs were luted using a self-adhesive resin cement (RelyX Unicem, 3M ESPE, Seefeld, Germany). The clinical procedures were made by undergraduate students, while the 7-year follow-up was performed by an experienced blinded dentist. At the baseline, no signs of periodontal disease were observed. The incisors, canines, premolars, and molars were included in the study. The final prosthetic restorations were SCs, FDPs, SC-supported RPDs, and FPD-supported RPDs.

Table 1 Excluded studies and reasons for exclusion

Study	Reason for exclusion
Mancebo et al. [17]	Excluded because the study focuses on endodontic treatments but does not report prosthetic failures and complications.
Juloski et al. [18]	Excluded because the study focuses on endodontic treatments and materials but prosthetic complications were not reported.

Methodological quality

The methodological quality assessment used in the present systematic review was reported in Table 2. Two independent reviewers evaluated the adequacy of records using a specific quality assessment protocol [16]. Any disagreement was discussed with a third experienced reviewer.

Mannocci et al. [19] got an adequate randomization level by tossing a coin; the inclusion and exclusion criteria were properly defined and the final follow-up interested more than 80% of study subjects; all the restorations were made by a single experienced operator and a good comparability between groups was obtained.

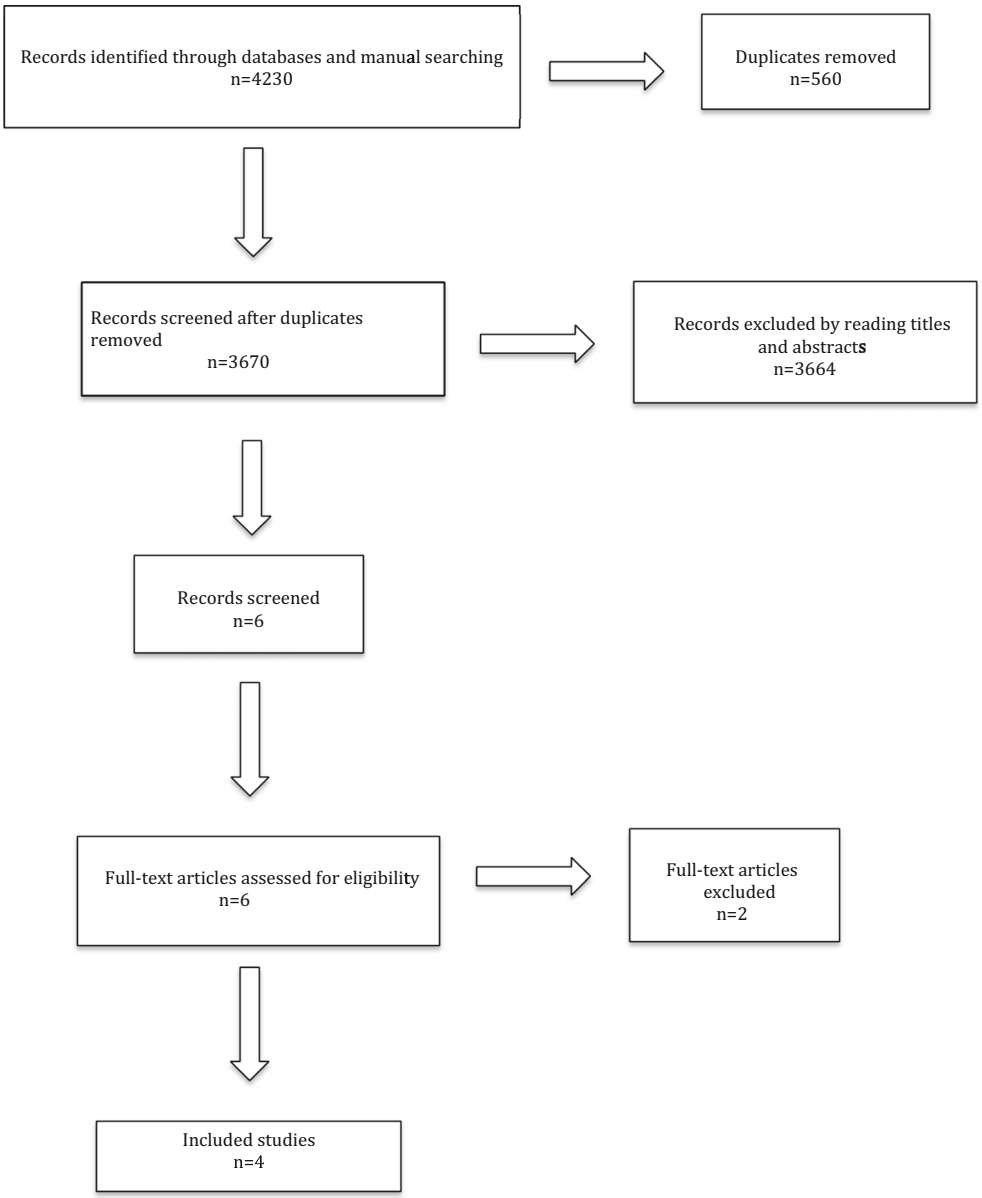

Fig. 1 Workflow of the paper screening process

In the study by Schmitter et al. [20], the randomization of the participants was adequate; computerized randomization was made by a professional nurse. The calculation of the sample size was not mentioned but the inclusion and exclusion criteria were properly defined: type of interventions, type of outcomes, and type of participants were specified. The 5-year follow-up was achieved for more than 80 % of the study sample. All the patients and the operators were blinded about the type of post used. The drop outs were adequately reported and there was a good comparability between groups.

In the study by Ferrari et al. [21], there was an adequate randomization of the participants. The inclusion and exclusion criteria were well defined and the follow-up regarded more than 80 % of the patients. The adopted clinical protocols did not allow blinding of the operators; intention-to-treat (ITT) correction was not applied and the sample size was not calculated. Nonetheless, a good comparability between groups was obtained.

In the study by Sterzenbach et al. [22], a satisfactory level of randomization of the participants was achieved by means of a computer-generated random list. The inclusion and exclusion criteria were clearly defined. No sample size calculation was performed and 80 % of the study population completed the follow-up period. Withdrawing was adequately described and included in the analysis, and there was a good comparability between the groups.

Table 2 Quality assessment of the studies included in the review

Sterzenbach et al. [22]	Ferrari et al. [21]	Schmitter et al. [20]	Mannocci et al. [19]	
L	L	L	L	Randomization
H	H	H	H	Calculation of sample size
L	L	L	L	Inclusion/ exclusion criteria
L	L	L	L	Follow-up achieved
L	H	L	H	Blind treatment
L	H	U	H	Withdrawing
L	L	L	L	Groups comparability

L low risk of bias, *U* unclear, *H* high risk of bias

Comparison of results

Comparison between fiber posts and prosthesis failure events

In the study by Mannocci et al. [19], no failures were observed at the 1-year recall. Conversely, after 2 and 3 years of function in group 1 (only direct composite restorations), one loss of retention of a fiber post and three marginal gap openings were found; in group 2 (composite buildup + SC), two decementation of fiber posts and one marginal gap opening were observed. The failure rate was 6 % and no statistically significant differences were found between groups.

In the study by Schmitter et al. [20], in the fiber post group, 11 failures were observed: 2 losses of retention of fiber posts, 2 chipped or fractured SCs, 1 apical alteration and 6 teeth in need to be extracted due to post-core-crown complex loosening; thus, the survival rate of the teeth treated using fiber posts was 71.8 %. In the metal screw post group, 21 failures were observed: 1 post and 1 crown needed recementation, 1 tooth needed a new post, 17 teeth were extracted due to root fractures, 1 apical alteration, and 1 crown failure occurred; consequently, the survival rate of the teeth restored with metal posts was 50 %. Cox regression was performed in order to evaluate the influence of the analyzed variables, and it revealed that anterior teeth, the teeth with a significant loss of coronal structure and the teeth restored with metal screw posts, showed higher risk of failure.

In the study by Ferrari et al. [21], after 6 years, the overall survival rate was 94.1 %. In the group without posts, the largest number of root fractures and crown dislodgements was observed. In the group with prefabricated posts, no crown dislodgement was observed but 12 post decementations and 1 root fracture were noticed. The teeth with four coronal residual walls were failure free. In this study, root canal retention was a significant factor for survival of the teeth, as assessed by Cox regression. The interaction between the type of restoration and the residual dentin was not statistically significant.

In the study by Sterzenbach et al. [22], over 7 years of observation, the overall survival rate was 89 %. In the titanium post group, the two maxillary lateral incisors and one mandibular molar showed endodontic failures. In the glass fiber post group, two root fractures, one tooth mobility (score 3), and one core fracture were observed.

There were no studies reporting the incidence of complications of endodontically treated teeth restored with fiber posts and FDPs.

Comparison between failure rates of subgroups

The secondary objective of the present systematic review was not fulfilled because there were no studies reporting differences in failure rates between subgroups (i.e., fiber posts and SC or fiber posts and FDP) in relation to ferrule height, type, and location of the teeth.

Discussion

Intraradicular posts were introduced in clinical practice to ensure the retention of restorations to the teeth missing a significative amount of their structure [23].

Several studies demonstrated that fiber posts performed better than metal posts due to their lower modulus of elasticity (*E*) compared to metal posts and similar to that of dentine (42 GPa) [24], with a lower incidence of root fractures in the long-term [25]. However, in some cases, such a modulus of elasticity was associated with excessive stress and strains, causing marginal gap opening and post debonding, which were reported to be the most frequent failures [10].

Different factors can influence the survival rates of post systems, just like type of post, luting cement, tooth position, shape of root canal, and final prosthetic restoration. In particular, the luting system of fiber posts significantly affected their clinical performances; self-adhesive resin cements proved to be most effective in the long-term in vitro, probably because less sensitive to the skill of the operator [26]. Conversely, several clinical studies suggested that the bond strength of self-adhesive cements is lower than the bond strength generated by traditional adhesive cementation techniques [27]. Moreover, it has been pointed out that resin cements could achieve poor adhesion to prefabricated fiber posts just like FRC posts due to the presence of a cross-linked polymer matrix between their fibers; in such cases, adhesive failures could be reduced by means of the interpenetrating polymer network (IPN) mechanism, as suggested by La Bell et al. [28].

According to the selected inclusion and exclusion criteria, four RCTs were included in this systematic review and the results were reported in the Table 3.

The shortest mean observational period (36 months) was reported in the study by Mannocci et al. [19]; differently, in the RCT by Ferrari et al. [21], 360 teeth were analyzed over a period of 72 months, which was the longest among the included studies. The lowest number of teeth ($n = 91$) was analyzed by Sterzenbach et al. [22]. Mannocci et al. [19] and Ferrari et al. [21] evaluated only the premolars, whereas Sterzenbach et al. [22] and Schmitter et al. [20] assessed both the anterior and posterior teeth.

As to the length of posts, different approaches were used in the studies included in the present review. In the study by Mannocci et al. [19], the fiber post length was 7 mm; Schmitter et al. [20] extended fiber posts to at least 50 % of the length of the root canal; Ferrari et al. [21] and Sterzenbach et al. [22] left an apical seal of at least 4 mm of root canal filling. The results of the included studies pointed out an adequate resistance of fiber posts placed with intermediate length, which is in agreement with previous investigations [29, 30].

The most frequently reported failures were fiber post debonding and crown dislodgements; only Schmitter et al. [20] described crack or chipping of the restorations and post-core-crown complex loosening.

Both the highest and the lowest failure rates were reported by Ferrari et al. [21]: 0 % in the group of 60 premolars with 4 residual coronal walls and 77.2 % in case of ferrule absence, respectively. The same authors evidenced that, in the teeth without residual dentine walls, there were no significant differences in the failure rates with or without ferrule. The preservation of at least one coronal wall significantly reduced the risk of failure, which is also pointed out by current published literature [31]; however, the relationship between residual coronal structure and type of prosthetic complication were not statistically significant.

Mannocci et al. [19] reported no statistically significant differences in failure rates between the teeth restored with direct composite restorations and metal-ceramic SCs. However, several studies in the literature suggested that SCs would be desirable to improve the survival rates of the restorations involving endodontically treated teeth restored with fiber posts, reducing the risk of fracture [12].

In the study by Schmitter et al. [20], the anterior teeth with a significant destruction of coronal structure and the teeth restored with metal screw posts showed higher risks of failure and these results were in agreement with previous investigations [13]. However, in this study, the quality assessment reported a high risk of bias: neither calculation of the sample size nor intention-to-treat analysis was performed.

In the studies by Schmitter et al. [20] and Sterzenbach et al. [22], the number of opposing teeth in occlusion, type of

Table 3 Characteristics of the studies included in the review

Sterzenbach et al. [22]	Ferrari et al. [21]	Schmitter et al. [20]	Mannocci et al. [19]	Study
71.2 months	72 months	61.37 months	36 months	Mean observational period
91	360	100	117	No. of included teeth
0–2 walls; 2 mm-ferrule	1–4 walls; absence/presence ferrule	At least 60 % of coronal structure	Class II premolars	Amount of residual coronal structure
Fiberpoints Root Pins Glass, Schutz Dental Group, Rosbach, Germany [Glass fiber posts]	DT Light Posts, RTD, St. Egreve, France [Quartz fiber posts]; EverStick Fibers, Stick Tech Ltd., Turku, Finland [Glass fiber posts]	ER dentine post, Brasseler, GA, USA [Glass fiber posts]	Composipost, RTD, Sr Egreve, France [Carbon fiber posts]	Fiber post type, brand name and manufacturer
PFM SCs, FDPs, SC-supported RDPs, FDPs-RPDs	PFM	SCs, FDPs, SC-supported RPDs	Direct composite, PFM	Type of restoration
Incisors, canines, premolars, and molars	Premolars	Incisors, canines, premolars, and molars	Premolars	Tooth type
9.8 %	0 % (4 walls); 21.1 % (3 walls); 30.2 % (2 walls); 47 % (1 wall); 66 % (ferrule present); 77.2 % (ferrule absent)	28.2 %	6 %	Failure rate

antagonist, and presence of malocclusions at the baseline were not specified. Operator blinding was not possible in the studies by Mannocci et al. [19] and Ferrari et al. [21], since the clinical protocols were different in relation to the type of post. In the research by Sterzenbach et al. [22], the clinical procedures were performed by operators with different experience and this could have affected the final results. Moreover, in the study by Sterzenbach et al. [22], it was not clear which type of prosthetic restoration was referred to a specific failure event.

Only in the study by Sterzenbach et al. [22], FDPs were used as final restorations but the failure rates of fiber posts were reported without taking into account the differences between SCs, FDPs, and RPDs supported by SCs or FDPs. No study reported a calculation of the sample size, and only in the RCT by Sterzenbach et al. [22] the intention-to-treat (ITT) analysis was applied. If ITT analysis and calculation of the sample size are not performed, an effect that is not truly present could be wrongly detected, leading to a distortion of the results of the analysis (i.e., false positive) and to a difficult interpretation of the results of an investigation. Furthermore, only Mannocci et al. [19] reported the maxillary and mandibular location of the teeth. Differences in failure rates between the mono and multiradicular teeth are not discussed; the biomechanical behavior of a maxillary incisor is highly different from that of a mandibular molar and, consequently, not reporting the location of the teeth represents a bias leading to an ambiguous interpretation of the results of an investigation. Furthermore, no study considered the so-called "pseudoferrules": indeed, the ferrule may exist but the form of its preparation is not correctly made and this could affect the resistance for tilting. All these factors could have affected the results of the included studies.

Recently, a systematic review and meta-analysis by Figueiredo et al. [5] showed that fiber and metal posts resulted in similar incidence of root fractures and survival rates, not supporting the indications for fiber posts based on the reduction of failures; however, the authors reported that the included studies presented high risks of bias. Similarly, the present systematic review shows some limitations, such as language bias, strict inclusion criteria and few included RCTs presenting high risk of bias. The lack of studies with high methodological quality was confirmed by Schmitter et al. [32], which noticed that the reviews with the highest R-AMSTAR scores reported lower failure rates for fiber posts; however, no definitive clinical conclusions can be found due to the limited number of available high quality studies.

For future research, further RCTs focused on biological, technical, and esthetical prosthetic complications of endodontically treated teeth restored with fiber posts would be desirable to better understand how different types of prosthetic restorations could affect the survival of fiber posts.

Conclusions

According to the inclusion and exclusion criteria selected in the present systematic review of the literature, the included studies were too heterogeneous and scarcely comparable to achieve clear clinical statements; furthermore, to date, a univocal correlation between failure rates of fiber posts and typology of prosthetic restorations (SC or FDP) cannot be found.

Within the limitations of this systematic review and the lack of available clinical data, the majority of failure events were due to post debonding and dislodgements of SCs.

Further clinical data are needed in order to establish a possible correlation between failures and typology of restoration, so as to postulate predictable guidelines in the restoration of endodontically treated teeth.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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Ethical approval This article does not contain any studies with human participants or animals performed by any of the authors.

Informed consent For this type of study, formal consent is not required.

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