ISSN-E: 18735347-02779536

Survival Rate of Fiber Post with Direct Composite Restoration: A Systematic Review

Haitham Binhuraib , Sahar Alhajrassi , Othman Alsulaimani , Manal Bediwi ,Ibrahim Lafi Alharthi , Ziyad Sarhan Alosaimi , Aws Mohammed Filemban , Joud Omar Alahmadi

ISSN-E: 18735347-02779536

ISSN-E: 18735347-02779536

Abstract:

Background: Dental posts are used to provide retention for dental restorations with severe hard tissue loss. The increasing demand for aesthetics has led to the invention of fiber-reinforced posts, which have numerous benefits due to favorable mechanical properties. The survival rates of fiber-reinforced restorations vary widely and depend on the follow-up period.

Aim: The aim of the current systematic review is to the survival rate of fiber post with direct composite restoration.

Design: systematic review procedures in order to ensure that bias is minimized and transparency is enhanced. The PRISMA 2020 version was used. The PICOT model was used to guide the search strategy. In current study, electronic resources include MEDLINE - Web of science - EMBASE – PubMed, Google Scholar and ProQuest are checked out with search for all clinical studies which were published related to evaluation. 2172 studies, all of which were in the four electronic databases specified in the current study. The studies collected in EndNote, then imported into Covidence, and duplicate files were filtered, which amounted to 470 studies, which were deleted. Inclusion and exclusion criteria were applied, the number of studies became 27 studies, 15 studies were excluded due to the lack of full text and their incompatibility with the proposed research design, and the studies most relevant to the systematic review question that met the inclusion criteria became 13 studies.

Results: Survival rate of fiber post with direct composite restoration was 90% with annual failure rate was 6%. The lowest survival rate (48%). The study used quartz fibers and the follow-up periods ranged from 1 to 6 years. The ARF rate was 11.63% in the first year and continued to increase with the increase in follow-up years until it reached 100% after the sixth year.

Conclusion: Fiber posts are the best alternative for the restoration of fractured endodontically treated teeth

Keywords: Survival rate - fiber post - direct composite restoration

ISSN-E: 18735347-02779536

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الملخص

تُستخدم أعمدة الأسنان لتوفير الاحتفاظ بحشوات الأسنان التي تعاني من فقدان شديد للأنسجة الصلبة. أدى الطلب المتزايد على الجماليات إلى اختراع أعمدة مقواة بالألياف، والتي لها فوائد عديدة بسبب الخصائص الميكانيكية المواتية. تختلف معدلات بقاء الحشوات المقواة بالألياف على نطاق واسع وتعتمد على فترة المتابعة.يهدف المراجعة المنهجية الحالية إلى معدل بقاء أعمدة الألياف مع الترميم المركب المباشر .

المنهجية: تم إجراءات مراجعة منهجية لضمان تقليل التحيز وتعزيز الشفافية. تم استخدام إصدار .PRISMA 2020 تم استخدام نموذج بايكوت لتوجيه استراتيجية البحث. في الدراسة الحالية، تشمل الموارد الإلكترونية جوجل سكولار للعلوم و بروكويست يتم التحقق منها مع البحث عن جميع الدراسات السريرية التي نُشرت فيما يتعلق بالتقييم. 2172 دراسة، كانت جميعها في قواعد البيانات الإلكترونية الأربع المحددة في الدراسة الحالية. تم جمع الدراسات في برنامج EndNote ثم استيرادها إلى برنامج ثقة وتم تصفية الملفات المكررة والتي بلغت 470 دراسة وتم حذفها وتم تطبيق معايير الإدراج والاستبعاد فأصبح عدد الدراسات 27 دراسة وتم استبعاد 15 دراسة لعدم توفر النص الكامل وعدم توافقها مع تصميم البحث المقترح وأصبحت الدراسات الأكثر صلة بسؤال المراجعة المنهجية والتي استوفت معايير الإدراج 13 دراسة.

النتائج: كانت نسبة البقاء على قيد الحياة للألياف بعد الترميم المباشر بالمركبات 90% مع معدل فشل سنوي 6% وكان أقل معدل بقاء (48%) وقد استخدمت الدراسة ألياف الكوارتز وتراوحت فترات المتابعة من سنة إلى 6 سنوات وكان معدل الفشل 11.63% في السنة الأولى واستمر في الزيادة مع زيادة سنوات المتابعة حتى وصل إلى 100% بعد السنة السادسة.

الخلاصة: أعمدة الألياف هي البديل الأفضل لترميم الأسنان المكسورة المعالجة باللب

الكلمات المفتاحية: نسبة البقاء على قيد الحياة - أعمدة الألياف - الترميم المباشر بالمركبات

ISSN-E: 18735347-02779536

Introduction:

Dental treatments aim to preserve the appearance of the tooth, restore lost function, maintain the integrity of the tissues and the physical structure of the tooth, and enhance the hard tissues of the tooth with appropriate restorative materials. Therefore, when choosing a restorative material, it should have a combination of mechanical and morphological properties that contribute to achieving minimal material loss of the tooth, its suitability to its structure, and its greater biocompatibility with oral tissues (Akkayan & Gülmez, 2002). Endodontic-treated teeth (ETT) differ structurally from non-restored vital teeth and require specific restorative treatment (Al-Omiri, Rayyan, & Abu-Hammad, 2010). Endodontic-treated teeth have a higher risk of fracture, a long-term dental problem. Initially, decreased dentin moisture and collagen bonding were considered the main causes. Understanding has evolved, with factors such as missing tooth structure and biomechanical changes now recognized as contributors (Bitter, Neumann, Kielbassa, & Meyer-Lueckel, 2009). However, the main cause of ETT fractures is actually changes in tooth structure (Bolla et al., 2007). Root canal treatment can reduce the strength of the tooth structure, increase apical deviation, and increase the risk of microleakage and fracture. The ETT also lacks proprioception, which increases the risk of fracture (Bolla et al., 2007).

Metal posts have been widely used because they save time and money, but they are rigid and cause stress and root fracture, which contributed to the development of more flexible posts, namely fiber-reinforced composite posts, which have many physical properties that make them the best alternative to metal posts (Cagidiaco, Goracci, Garcia-Godoy, & Ferrari, 2008). Fiber posts are commonly used in the restoration of endodontic-treated teeth to improve the retention and stability of the underlying building materials, as well as to strengthen the weak tooth structure (Creugers, Mentink, Fokkinga, & Käyser, 1993). Several types of fiber posts are available, including fiberglass posts, carbon fiber posts, quartz fiber posts, and zirconia fiber posts. Due to providing dentin-like elastic properties while maintaining strength and translucency and achieving an acceptable aesthetic source, fiber-reinforced composite posts have been used in conjunction with a composite resin core material in the restoration of endodontically treated teeth that have weakness or deformity. Especially since these fiber-reinforced composite materials reduce polymerization shrinkage and are more bonded to resin adhesives, and are more resistant to compressive forces. Selecting the appropriate type of posts is essential for the success of post-endodontic restorations. FRC posts have favorable biomechanical properties and the ability to enhance light transmission through the root canal space (Creugers, Mentink, Fokkinga, & Käyser, 1993).

Endodontic retreatment is also easier with the use of fiber post as fiber posts can be removed more easily than metal or ceramic posts. A positive correlation has been observed between crown placement and survival of endodontically treated teeth when tooth structure loss is extensive. The deflection characteristics of fiber-bonded composite posts have been shown to protect remaining tooth structures. Indications for fiber post placement include restoration of endodontically treated teeth and improved retention and stability of pulp building materials. Fiber posts are contraindicated in cases of severely damaged or weakened root canals, insufficient tooth structure to retain the post, poor quality of root canal obturation, and dysfunctional habits such as bruxism(Creugers, Mentink, Fokkinga, & Käyser, 1993) .

Endodontic treated teeth usually show significant loss of tooth structure, especially the crown, due to caries or fractures, which necessitates the use of an intra-root post to retain the final crown restoration, strengthen the tooth, and reduce stress on the tooth. Thus, the fiber post is the most suitable alternative for the tooth structure, which creates uniformity of stress on the root, reducing the risk of catastrophic failure. Excessive removal of root and crown dentin tissues usually occurs as a result of endodontic procedures, which results in the appearance of excessively wide canals that require an intra-root post to retain the pulp. With the advancement in the use of fibers after direct restoration with composites, which have shown high results in restoring large posterior cavities to reach a level closer to the natural cavity before endodontic treatment (Drummond, 2008).

Fiber posts are typically fixed using an adhesive resin-based cement, such as dual-cure or self-adhesive resin cement. Proper drilling, priming, and bonding of the root canal walls and post surfaces are essential for successful fixation. The length of the fiber post should generally be approximately two-thirds of the root canal length, and the diameter of the post should be approximately one-third of the root canal width. The preparation process involves removing the root canal filling, preparing the post space using a specific drill, cleaning and disinfecting the post space, drilling, and applying adhesive systems. The restoration process typically involves placement of the fiber post, building up the pulp with composite resin or resin-modified glass ionomer cement, and the final restoration, such as a crown or bridge. Fiber posts offer superior esthetics compared to metal posts and have a similar modulus of elasticity to dentin, reducing the risk of root fracture. Proper case selection and treatment planning are essential for successful outcomes

(Eskitascioglu, Belli, & Kalkan, 2002).

Technological advances in fiber-reinforced materials have led to continued development of fiber posts, requiring further clinical research to investigate the long-term performance of endodontically treated teeth using fibers after direct composite restorations. Retrospective and prospective clinical studies on the use of fiber posts to restore endodontically treated teeth have been encouraging. Fiber post survival rates ranged from 2-7.7% in retrospective studies and from 1.7% to 12.8% in prospective studies (Faria et al., 2011). The clinical success rate of fiber posts ranged from 89% to 98% in retrospective studies and from 92% to 99% in prospective studies. Unfortunately, the clinical studies that have been conducted to evaluate fiber survival rates after direct composite restorations have been short-term studies of 2-3 years of clinical service, and although it is recognized that their results indicate good performance, the need for long-term clinical studies has become urgent to determine whether the previously reported results are of clinical significance. The clinical properties and performance of fiber-reinforced columns have been extensively studied, but most studies have been in vitro or clinical studies with small sample size and short follow-up time. Therefore, it remains unclear whether fiber-reinforced columns represent a reliable alternative, and clinicians often choose a type of column based on their personal judgment rather than scientific evidence (Figueiredo, Martins-Filho, & Faria-E-Silva, 2015).

Although there are many clinical studies that have shown results that improve tooth appearance and evaluate the use of fiber-reinforced composite abutments well, they suffer from methodological limitations that limit direct clinical application and call for more clinical research to reach the highest level of evidence and achieve the best results supporting the guidance of clinical decisions using fiber-reinforced composite abutments. Other studies have found no difference or even the opposite regarding fracture pattern. Studies have been conducted to measure one aspect of post-restoration failure such as fractures, repetitive loading, and post-restoration dependence (Zogheib, Pereira, Valle, de Oliveira, & Pegoraro, 2011). There has been no systematic review to summarize all the results and determine the survival rate of restorations after restorations without crown coverage. Therefore, the current study aims to conduct a systematic review to identify the survival rate of fiber post with direct composite restoration (Frater, Lassila, & Vallittu, 2011).

Review Questions:

The current systematic review attempts to answer the main study question: What is the survival rate of fiber post with direct composite restoration?

Aims and Objectives

Aim:

The aim of the current systematic review is to the survival rate of fiber post with direct composite restoration.

Objectives:

The main objectives of the current review are:

1. Assess survival rates of endodontically-treated teeth restored with fiber posts and direct composite.
2. Identify and compare failure modes (root/post fracture, documentation, gaps, caries).
3. Evaluate influence of tooth position (maxilla vs mandible) on long-term survival.
4. Provide evidence-based guidance on restoration options for endodontically-treated teeth with limited coronal structure.

Methodology:

The researchers took care to prepare a review protocol that is consistent with the JBI systematic review procedures in order to ensure that bias is minimized and transparency is enhanced. The PRISMA 2020 version was used. The PICOT model was used to guide the search strategy, which aims to identify the population, interventions, context, outcomes of interventions, and timeframe of practice. Digital databases, grey research sources, hand searching, and the Cochrane

Database of Systematic Reviews and Evidence Synthesis were searched. The searches did not yield any systematic reviews related to the research topic “survival rate of fiber post with direct composite restoration”. The current systematic review protocol includes the following steps: identifying keywords, searching databases and other data collection sources, selecting included studies, assessing the quality of studies according to inclusion and exclusion criteria, extracting data from included studies, and analyzing data to answer the methodological question (Zhou & Wang, 2013).

Eligibility criteria:

The researchers identified a set of inclusion and exclusion criteria with the aim of maintaining objectivity and impartiality, which serve as conditions for selecting studies and determining their quality. (Zicari, Van Meerbeek, Debels, Moors, & Naert, 2012), these criteria relate to the research design, the groups of participants in the studies, or the type of clinical interventions used and the duration of their use, in order to answer the main systematic review question, which is “What is survival rate of fiber post with direct composite restoration?”

Inclusion Criteria:

- **Publication Date:** Studies published between January 1, 2000 and November 30, 2024, which aim to explore the survival rate of fiber post with direct composite restoration.
- **Language:** Articles in English.
- **Design:** Clinical studies of fiber post with direct composite restoration.
- **Target population:** All patients with endodontically treated teeth, regardless of nationality or age
- **Exposure:** Use of fiber post with direct composite restoration.
- **Outcomes:** All views, perceptions, comments, observations, experiences, expressions and feelings about use of fiber post with direct composite restoration, survival rate, and failure patterns.

Exclusion Criteria:

- **Publication Date:** Studies published before January 1, 2000 were excluded.
- **Design:** In vitro studies done in human extracted teeth, Review, Abstract, Case reports and Letter to editorials were excluded.
- **Exposure:** Studies that did not include fiber post with direct composite restoration were excluded.

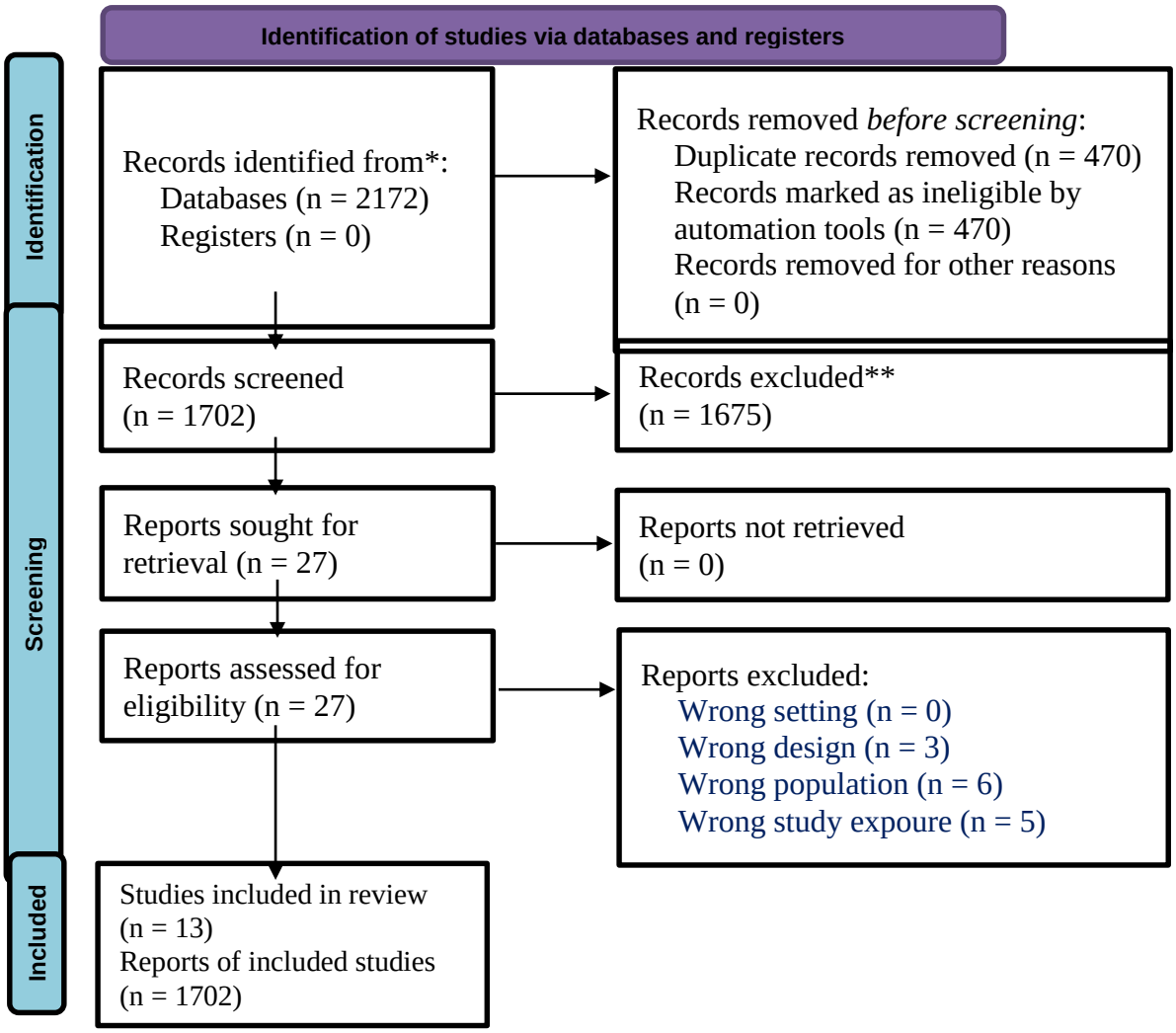
Search strategy:

In accordance with (Hayashi, Takahashi, Imazato, & Ebisu, 2008), a systematic review should begin by searching databases and data collection sources for any previous systematic review that addressed the research variables or targeted the same research question as the systematic review. Therefore, the researchers conducted a scoping search to ensure that no systematic review or protocol registration had been completed regarding "What is survival rate of fiber post with direct composite restoration". Indeed, there was no systematic review or protocol registration that targeted the current systematic review question. The four electronic databases that were explored: (MEDLINE - Web of science - EMBASE - PubMed). According to (Hayashi, Takahashi, Imazato, & Ebisu, 2008), it is not possible to rely solely on articles published in electronic databases, so the researchers resorted to searching databases specialized in gray literature such as the Open Grey database using the same keywords that were addressed in the search strategy in the four electronic databases, and this search did not yield any additional results. To ensure the comprehensiveness of the research and the accuracy of the information intended to be generalized in clinical practice, the researchers resorted to expanding the search operations through manual search and searching in Google Scholar in the English language, and also by searching in ProQuest via the digital library website to review master's and doctoral theses. The search results did not yield any additional studies that could be included. The researchers used the key word (Fiber post, (Vano, Cury, Goracci, Chieffi, & Ferrari, 2006) Direct composite restoration, Adhesive restoration, Endodontically treated teeth and survival rate) using the logical operator “OR” to search for variables individually, used "AND" to combine these variables together (Sorensen & Engelman, 1990).

Selection strategy:

The researchers agreed to divide themselves to two research teams, each of them working independently, and agreed to implement a plan to access the included studies with precision by initially expanding the search scope without restrictions, then filtering these studies according to the inclusion and exclusion criteria to ensure the absence of bias. The two teams used the same keywords and the same "OR" operator to use different individual variables, and used the "AND" operator to combine a group of keywords together to achieve a greater connection between the extracted studies and the systematic review question. Then, the results compared between the two teams and discussed to access the extracted studies with precision. The findings of the search process resulted in the presence of 2172 studies, all of which were in the four electronic databases specified in the current study. The studies collected in EndNote, then imported into Covidence, and duplicate files were filtered, which amounted to 470 studies, which were deleted. Inclusion and exclusion criteria were applied, the number of studies became 27 studies, 15 studies were excluded due to the lack of full text and their incompatibility with the proposed research design, and the studies most relevant to the systematic review question that met the inclusion criteria became 13 studies.

PRISMA 2020 flow diagram for new systematic reviews which included searches of databases and registers only



Quality assessment of included studies:

The researchers sought to assess the quality of the included studies in order to reduce bias and ensure the validity of these studies as a source of data that can be relied upon to answer the systematic review question. The researchers also aimed through this procedure to make a final decision to include or exclude the study based on its quality assessment, and then the credibility of the source and the confidence in the results that will be generalized as a guide for clinical practice can be judged. The researchers used a tool for systematic review quality assessment, consists of six criteria, which are (Random sequence generation (selection bias), Allocation concealment (selection bias), Blinding of participants/personnel (performance bias), Blinding of outcome assessment (detection bias), Completeness of outcome data (attrition bias), Selective outcome reporting (reporting bias)). To ensure that none of the included studies were biased, the two teams conducted the evaluation process individually and then discussed the results of the critical evaluation to reach a final opinion on the included studies.

Table: Quality assessment of included studies

	Ayna et al., [32]	ElAziz et al., [8]	Ferrari et al., [13]	Ghavamnasiri et al., [26]	Guldener et al., [33]	Jurema et al., [34]	Mannocci et al., [35]	Naumann et al., [36]	Parisi et al., [37]	Perrin et al., [38]	Poletto-Neto et al., [39]	Mohan et al., [7]	Bijelic-Donova et al., [40]
Random sequence generation (selection bias)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Allocation concealment (selection bias)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Blinding of participants/personnel (performance bias)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Blinding of outcome assessment (detection bias)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Completeness of outcome data (attrition bias)	✓	؟	✓	؟	✓	؟	✓	؟	✓	؟	✓	✓	؟
Selective outcome reporting (reporting bias)	✓	؟	؟	✓	✓	؟	✓	؟	؟	✓	؟	؟	؟
Overall quality rating	6	4	5	5	6	4	6	4	5	5	5	5	4
Percent	100	67	83	83	100	67	100	67	83	83	83	83	67

It is clear from the quality assessment of the included studies that they all obtained a rate of (67-100%), which are high levels that confirm the absence of bias and confidence in the quality of the results of the systematic review of these studies and confidence in the generalization of the results extracted from them.

Data Extraction:

JBI systematic reviews require the use of a standardized data extraction tool to ensure that the data extracted from all included studies are consistent, which facilitates their analysis, comparison, and critique, and facilitates the review and tracking of these data. The researchers developed a standardized data extraction form to collect relevant information from the included studies, such as study characteristics, patient demographics, recovery details, and outcome data. The review team conducted a thorough and careful reading of the 13 included studies, repeating the reading process more than once to ensure credibility, and extracted data related to the survival rate of fiber post with direct composite restoration.

Data Synthesis:

The researchers will perform a narrative synthesis to describe the included studies and their findings. Consider conducting a meta-analysis to pool the survival rates or other outcomes, if the studies are sufficiently homogeneous in terms of population, intervention, and outcome measures. Assess the heterogeneity among the included studies and explore potential sources of heterogeneity through subgroup analyses or meta-regression.

Results:

The screening process is summarized in the PRISMA flow chart in Figure 1. After scanning and checking according to the inclusion and exclusion criteria, 13 studies were selected to be included in the current study.

Characteristics of the included studies:

Table () shows the characteristics of the 13 included studies in terms of author name and year, follow up, definitive restoration, cement, type of post, number of teeth, treatment, failure, survival/success and annual failure rate. Limitations of these studies will be reviewed when discussing the results of the systematic review to provide an unbiased picture of each included article and so that the right decision can be made about the generalizability of these results or not.

Table () Characteristics of the included studies

Study, Year	Follow up	definitive restoration	Cement	Post	number;	Treatment.	Failure	Survival/ Success	Annual Failure Rate
Ayna et al., 2009	every year for up to three years	Direct composite restoration	A highly filled, dual-polymerizing hybrid resin - enamel dentine adhesive	polyethylene fibre-reinforced composite	87	coated with a dual-polymerizing resin composite (Liner Bond II V; Kuraray, Tokyo, Japan), and placed in a light-protective container	8	Survival 98%	AFR 2%
ElAziz et al., 2020	6 months 1 year	Direct composite restoration	Dual-curing adhesive resin cement	Glass fiber - Short-fiber-	67	Silane coupling agent	4	Survival 95%	AFR 5%
Ferrari et al., 2007	7-11 years	Direct composite restoration	All Bond 2c and One-Stepc in combination with C&Bc resin cement, Scotchbond Multi-Purpose Plusd in combination with Opal luting composited and Scotchbond 1d (Single-Bondd) with Rely Xd resin cement.	Three posts type: C-Post Æstheti Post (AP) Æstheti Post Plus (APP)	A total of 719 subjects were treated with the 850 C-Posts, 215 subjects with the 249 Æstheti Posts and 234 subjects with the 290 Æstheti Post Plus	N/A	A 7-11% failure rate was recorded for the three types of posts. 79 failures in total were noted; 39 due to endodontic reasons, 1 root fracture, 1 fiber post fracture, 17 crown dislodgements and 21 due to post debonding.	89-93%	7-11%
Ghavamnasiri et al., 2011	1-6 years	Direct composite	extensive composite resin	quartz fiber post	Thirty-eight patients with	N/A	survival probabilities	48.8%	ARF after 1, 2, 4, 5,

Study, Year	Follow up	definitive restoration	Cement	Post	number;	Treatment.	Failure	Survival/ Success	Annual Failure Rate
		restoration	restorations		endodontically treated premolar and anterior teeth		after 1, 2, 4, 5, and 6 years of service were 88.37%, 60.95%, 45.71%, 32.65%, and 0%, respectively		and 6 years of service were 11.63%, 39.05%, 54.29%, 67.35%, and 100%, respectively
Guldener et al., 2017	5 years	Direct composite restoration	teeth were restored with either a direct composite restoration or a single-unit crown	glass fiber post	144 singlerooted and multirooted teeth in 100 subjects	alcohol; Silane	survival rate of teeth with a fiber post amounted to 94.3%, and for teeth without a post, it was 76.3% (P < .001). The main reason for tooth loss was root fracture (9.7%). No loss of post retention was observed	overall tooth survival rate was 89.6%	10.4
Jurema et al., 2020	6 and 12 months	Direct composite restoration	A conventional composite resin (Amaris; VOCO) was used for the veneer with an incremental technique, and each increment was light polymerized for 10 s (translucent resin) or for 40 s (opaque resin).	glass fiber posts	Fifty participants had 1 maxillary anterior tooth	N/A	For control group, at the 6-month follow-up, one tooth had suffered a catastrophic failure, which resulted in tooth extraction	100	0

Study, Year	Follow up	definitive restoration	Cement	Post	number;	Treatment.	Failure	Survival/ Success	Annual Failure Rate
Mannocci et al., 2002	1, 2, and 3 years	Direct composite restoration	All teeth received a temporary restoration with a zinc oxide eugenol-free composite material	Carbon fiber posts	Sixty teeth were included in the first group and 57 in the second	N/A	failure modes observed at 2 and 3 years were decementations of posts and clinical and/or radiographic evidence of marginal gap between tooth and restoration	90	10
Naumann et al., 2004	12 and 24 months	Direct composite restoration	EBSw-Multi (3M ESPE) as adhesive system	glass fibre reinforced posts	Eighty-three patients got 105 glass fibre reinforced posts	alcohol, air dried and coated with a thin layer of bonding agent	post fractures	96.2% after 12 month, 87.2% after 24 month	3.8% of the restorations failed after 12 month, 12.8% after 24 month
Parisi et al., 2015	7 months to 9.25 years	composite restoration	the post was cemented with a bonding system (All-Bond 2; Bisco Inc), a resin cement (C&B selfpolymerizing resin cement; Bisco Inc); and a composite resin (BisCore; Bisco, Inc) was used for core restoration.	Quartz fiber posts	Ninety-nine teeth restored with 114 quartz fiber posts and FDPs were evaluated	N/A	Post debonding was the most frequent failure mode, followed by endodontic failure, with the latter not necessarily being related to the post itself. No root fractures were recorded	85.86% in a mean period of 5.88 ±1.37 years, with an estimated success probability of 85% at 6.17 years overall survival rate of the teeth to 98%	2%
Perrin et al., 2020	53 months	Direct composite restoration	A three step etch and rinse adhesive system was applied	DFRC-FPD were reinforced by fiber-	100 DFRC-FPD were directly applied	silane and bonding agent	fracture of the composite material	93%	1.6%

Study, Year	Follow up	definitive restoration	Cement	Post	number;	Treatment.	Failure	Survival/ Success	Annual Failure Rate
			(Ultraetch, Ultradent Products, South Jordan, USA; Optibond FL Primer and Adhesive, KerrHawe SA, Bioggio, Switzerland).	splints with semi polymer network matrices (Everstick C + B©)					
Poletto-Neto et al., 2024	8.1 years	composite restorations	regular or self-adhesive, and crown or composite resin	glass fiber post	34 metal-ceramic crowns and 41 composite restorations	alcohol; Silane	composite resin metal-ceramic crown	85.0 % for crowns (AFR=1.31 %) and 43.2 % for composite resins (AFR=6.58 %), while the survival rate was 93.8 % for crowns (AFR=0.52 %) and 97.6 % for composite resins (AFR=0.20 %)	For crowns (AFR=0.52 %) and for composite resins (AFR=0.20 %)
Mohan et al., 2015	6 months	Direct composite restoration	dual cure adhesive resin	Glass fiber posts	64	N/A	causes of failure were post and core fracture or dislodgement	92.2%	5.92%
Bijelic-Donova et al., 2022	4 years	Direct composite restoration	Self-adhesive resin cement	Glass fiber posts	18	Silane	Secondary caries; replacement	90.9%	6%

Study, Year	Follow up	definitive restoration	Cement	Post	number;	Treatment.	Failure	Survival/ Success	Annual Failure Rate
			(Relyx Unicem, 3M ESPE)						

Survival rate of fiber post with direct composite restoration:

Study, Year	Follow up	Post	Survival/ Success	Annual Failure Rate
Ayna et al., 2009	1-3 years	polyethylene fibre- reinforced composite	98%	AFR 2%
ElAziz et al., 2020	6 m - 1 year	Glass fiber - Short-fiber-reinforced resin composite	95%	AFR 5%
Ferrari et al., 2007	7-11 years	Three posts type: C-Post, Æstheti Post (AP), Æstheti Post Plus (APP)	89-93%	7-11%
Ghavamnasiri et al., 2011	1-6 years	quartz fiber post	48.8%	ARF after 1, 2, 4, 5, and 6 years of service were 11.63%, 39.05%, 54.29%, 67.35%, and 100%,
Guldener et al., 2017	5 years	glass fiber post	89.6%	10.4
Jurema et al., 2020	6 - 12 months	glass fiber posts	100	0
Mannocci et al., 2002	1 - 3 years	Carbon fiber posts	90	10
Naumann et al., 2004	12 - 24 months	glass fibre reinforced posts	96.2% after 12 month, 87.2% after 24 month	3.8% of the restorations failed after 12 month, 12.8% after 24 month
Parisi et al., 2015	7 months to 9.25 years	Quartz fiber posts	98%	2%
Perrin et al., 2020	53 months	DFRC-FPD were reinforced by fiber-splints with semi polymer network matrices	93%	1.6%
Poletto-Neto et al., 2024	8.1 years	Glass fiber posts	93.8 % for crowns 97.6 % for composite	For crowns 0.52 % for composite resins 0.20 %
Mohan et al., 2015	6 months	Glass fiber posts	92.2%	5.92%
Bijelic-Donova et al., 2022	4 years	Glass fiber posts	90.9%	6%
Mean	4.85 year	-	90%	6%

The systematic review showed that the mean follow-up period of fiber post with direct composite restoration was 4.85 years; the lowest period was 6 months in Mohan et al., study while the highest period was 11 years in Ferrari et al., study. The type of post, Glass fiber posts were the most commonly used (Heydecke, Butz, & Strub, 2001).

Survival rate of fiber post with direct composite restoration was 90% with annual failure rate was 6%. The study by Ghavamnasiri et al. had the lowest survival rate (48%). The study used quartz fibers and the follow-up periods ranged from 1 to 6 years. The ARF rate was 11.63% in the first year and continued to increase with the increase in follow-up years until it reached 100% after the sixth year. The study by (Heydecke & Peters, 2002), had a 100% survival rate, but the follow-up period was short, only one year (Sorensen & Martinoff, 1984).

Discussion:

The null hypothesis that there is no difference in the survival rate of fiber-reinforced composite bridges with direct composite restorations is rejected. The success/ survival rates and distribution of failure modes were analyzed based on the data extracted from the included studies. The results of the current systematic review indicated a high survival rate of fiber post with direct composite restoration 90%, and glass fiber was the most commonly used as a fiber post type. The systematic review showed that the use of fiber-reinforced composite with direct composite restorations for molars and teeth is a successful and clinically effective use and achieves great sustainability for molars and teeth treated by dental endodontics and restored using fiber posts and direct composite restorations as the longest period of time with the least fractures. In accordance with (Heydecke & Peters, 2002), study confirmed the high survival rates of directly prepared fiber-reinforced composite bridges, and indicated extended success times of up to nine years. In addition, DFRC-FPD is an immediate short- to medium-term solution for replacing 1 to 2 missing teeth with no or minimal tooth preparation, in addition to being less expensive. In (Hu, Ao, & Liu, 2010), study, the results were confirmed that endodontic rehabilitation of teeth treated with light-transmitting quartz fiber posts and FDPs can be performed with a final survival rate of 98% for periods approaching 6 years. Researchers state that glass fiber posts are the best alternative for the restoration of fractured teeth treated with endodontics. Fiber posts and direct composite resin core materials are highly recommended for the restoration of deformed endodontic teeth. The follow-up period of this study and clinical evaluation extended from 1-6 months with a survival rate of 92.2%. The clinical performance of fiber posts was analyzed with consideration of the preservation of tooth structure, which is the most important aspect in increasing the survival rate of endodontically treated teeth (Skupien, Sarkis-Onofre, Cenci, Moraes, & Pereira-Cenci, 2016).

Vertical root fractures without posts are a serious and frequent problem. Therefore, (Juloski, Radovic, Goracci, Vulicevic, & Ferrari, 2012), demonstrated that endodontic treated teeth restored with fiber posts and direct composite had higher survival and success rates compared to teeth restored without fiber posts. In complex restorations, direct restorations using hybrid nano-resin composites can be a viable treatment option (Mazzitelli, Monticelli, Ferrari, & Toledano, 2008). The study confirmed that short fiber reinforced resin composite (SFRC) is a bulk direct-filled resin composite specifically designed for large complex cavities. It has high fracture toughness and load-bearing capacity to reduce the incidence of restoration fracture. In the (Naumann, Koelpin, Beuer, & Meyer-Lueckel, 2012), study that used glass fibers, the follow-up period lasted one year and the survival rate was 95%. It confirmed that both direct and indirect nanohybrid resin composite restorations have a successful clinical performance, but the preference for direct nanohybrid resin composite restorations is due to the low cost and ease of use, but at the same time it requires high skill from the operator and availability of patient time (Silva, Castro, Santos-Filho, & Simamoto-Júnior, 2011).

The survival rates of fiber post-based restorations vary widely, and failure rates ranging from 10 to 100% have been reported depending on the follow-up period. They found that the root fracture rate of carbon fiber posts was twice as high as that of glass fiber posts.

In the (Oliveira, Pereira, Valle, & Pegoraro, 2011), a review of 30 clinical papers showed that the survival rate of post-based restorations was between 48.8 and 100% from 6 months to 10 years of follow-up. Some researchers evaluated 24 clinical studies on the life cycle of fiber post-based restorations. The studies lasted from 1 to 10 years. The survival rate was between 48.8 and 100% at the end of follow-up (Schmitter, Seydler, & Ohlmann, 2012).

The present systematic review showed that the failure modes were: tooth problem: secondary caries, root fracture; restoration problems: crown detachment, restoration fracture; Post and pulp problems: loss of post retention, post deformity, post and pulp disengagement, post or pulp fracture; pulp problems. Post fracture detachment and tooth or

pulp fracture were the most common. The results of the present systematic review are in agreement with the review by (Ozer & Malkondu, 2014), which indicated that restorations based on fiber posts have acceptable survival in clinical conditions. (Plasmans, Creugers, & Mulder, 1998), study showed that the reconstruction of endodontically treated teeth using parallel-sided and tapered glass fiber-reinforced composite posts showed a similar failure rate after two years of service. Post-treatment fractures and loss of post retention were the most common types of failure. The majority of failures were reparable. The one- and two-year failure rates for fiber-reinforced composite post restorations were 4% and 12%, respectively. Fiber posts have excellent properties including flexibility, translucency, adaptability, durability, and resistance to abrasion and impact. They are also easy to apply, making them a viable alternative to conventional materials (Ricketts, Tait, & Higgins, 2005).

Conclusion:

Restoration of endodontically treated teeth using fiber posts and composite resin core materials is one of the most documented and scientifically supported techniques available. Fiber posts are the best alternative for the restoration of fractured endodontically treated teeth. Fiber posts and direct composite resin core materials are highly recommended for the restoration of deformed endodontically treated teeth. The use of fiber posts and fiber-reinforced composite resin core materials for direct restoration of endodontically treated teeth offers significant benefits: high clinical efficacy, minimal tooth tissue loss, good esthetics, and cost savings for patients compared to indirect restorations. It is clear that the survival rate of fiber post with direct composite restorations is very high.

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