Review Article

Efficacy of Glass Fiber Composite Restoration: A Systematic Review

Shereen Turkistani[1], Noura Alotaibi[1], Mashari Mulayfi Alanazi[2], Sulaiman Abdullah Alsanie[3], Badr Soliman Hussain[4], Shahzeb Hasan Ansari[5]*, Faisal Ahmad Alshehri[2]

[1]Department of Dentistry, Riyadh Elm University, Riyadh, Saudi Arabia. [2]Department of Dentistry, Ministry of Health, Riyadh, Saudi Arabia. [3]Department of Dentistry, Saudi TECMAR Polyclinic, Riyadh, Saudi Arabia. [4]Department of Restorative Dentistry, Prince Sultan Military Medical City, Riyadh, Saudi Arabia. [5]Department of Preventive Dentistry, Riyadh Elm University, Riyadh, Saudi Arabia.

Abstract

Fibers can be used as restorative materials during post-endodontic treatment to avoid tooth fractures. Fibers can modify the stress by initiating a Monoblock effect that aids to dispel the stress along the tooth's long axis. Fibers can also prevent the formation of cracks due to the dispersal of stress to the fibers from the polymer matrix. Glass fiber-reinforced composite is one of the materials that can be used in dentistry for restoration. It is known that enclosing glass fibers into a resin matrix produces glass fiber-reinforced composites. The objective of this study was to evaluate the efficacy of glass fiber-reinforced composite restoration. This study utilized a systematic review that involved searching the literature and selecting articles for review based on the set criteria for exclusion and inclusion. The study established that glass fiber-reinforced composite restoration recorded favorable outcomes compared to other non-fiber-reinforced composite materials and other composite materials. Glass fiber-reinforced composite materials are appropriate to be used for restoration based on their clinical efficacy.

Keywords: Glass fiber, Composite, Restoration, Systematic review

INTRODUCTION

There has been a radical transformation in the dental restorative industry in recent years that has seen a shift from traditional methods to novel alternate materials that record enhanced outcomes [1-3]. The treatment of the root canal results in a considerable lowering of the strength of the tooth, hence, it necessitating post-endodontic restoration to help it fortify. Raju *et al*. (2021) claim that flowable composites are utilized in bulk-fill and conventional modes since they are easy to handle and have the ability to penetrate the complex spaces of cavities [4]. However, as Shah *et al*. (2021) noted there is a need to consider the diminished tooth's elasticity and morphology of the lost structure of the tooth during post-endodontic treatment [5]. This idea means that the selection of the restoration material should be a careful endeavor that is reported in the existing literature.

Fibers can be used as restorative materials during post-endodontic treatment to avoid tooth fractures. Fibers can modify the stress by initiating a Monoblock effect that aids to dispel the stress along the tooth's long axis [5]. Fibers can also prevent the formation of cracks due to the dispersal of stress to the fibers from the polymer matrix. Specific fibers such as glass fibers, short fiber-reinforced composites, and polythene fibers can be leveraged as core materials. Polythene fiber-reinforced composites help in changing the pattern of the stress as well as transferring and distributing stress. On the other hand, glass fibers avail adequate aesthetics and a reinforcing capacity. Modifying effect on the stress provided by the composite polyethylene fiber combination [6].

Glass fiber-reinforced composite is one of the materials that can be used in dentistry for restoration. Safwat *et al*. (2021) assert that enclosing glass fibers into a resin matrix produces glass fiber-reinforced composites [7]. Glass fibers exist in numerous compositions such as E-glass, S-glass, D glass, AR glass, A glass, and C glass. These different forms of glass fibers have diverse uses and properties despite that they are all amorphous and formed of a 3-dimensional silica network characterized by a random arrangement of oxygen and other atoms [7]. Various advantages are associated with the use of glass fiber-reinforced composite in dental restoration. For instance, they provide non-corrosive, acceptable aesthetics,

Address for correspondence: Shahzeb Hasan Ansari, Department of Preventive Dentistry, Riyadh Elm University, Riyadh, Saudi Arabia.
shahzebhasan@riyadh.edu.sa

How to cite this article: Turkistani S, Alotaibi N, Alanazi MM, Alsanie SA, Hussain BS, Ansari S, et al. Efficacy of Glass Fiber Composite Restoration: A Systematic Review. Arch Pharm Pract. 2022;13(3):122-6. https://doi.org/10.51847/4UjmDsjJCQ

metal-free, high toughness, and non-allergic effect. Also, this dental material can be tailored to help address the specific needs of numerous dental applications. This systematic review aims to establish the efficacy of glass fiber-reinforced composite restoration in the dental industry.

Materials and Methods

The methodology discussed in this section includes the search strategy and the exclusion and inclusion criteria for the articles considered in the systematic review. The selection of articles was based on the Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. This guiding principle is comprised of various components such as the identification of articles, screening of the selected studies, eligibility, and inclusion. The PICO question that guided the research is as follows: Among patients undergoing dental restoration, how does the effectiveness of glass fiber-reinforced composite restoration compare to other restoration materials?

Search Strategy

The search strategy entailed looking for reliable sources to provide data that expound on the topic. As a result, different databases were used to obtain a variety of articles that availed data from different viewpoints based on the area of focus for each study. The first search strategy was to formulate keywords that could be used to narrow down the content of interest. The keywords include "glass fiber-reinforced composite" and "dental restoration." The databases utilized include EBSCO host, PubMed, SCOPUS, and Google Scholar.

Inclusion Criteria

For this systematic review, the inclusion criteria for articles included setting some requirements that must be met before a study is selected. The first criterion entailed identifying documents that focus on glass fiber-reinforced composite. Second, all articles that were peer-reviewed and scholarly were considered for review. Also, all the selected articles were printed in English. Finally, articles that discussed the restoration of endodontically treated teeth were considered for review.

Exclusion Criteria

The first criteria for exclusion entailed examining the abstract to determine whether the study focused on glass fiber-reinforced composite. Articles that focused on other dental restoration materials without mentioning glass fiber-reinforced composite were not included for review. Also, studies that had only abstracts without full access to the article were not considered for review.

The elaborate inclusion and exclusion strategy was meant to ensure that the selected articles are reliable in terms of the information contained therein. As a result, the obtained studies addressed the topic of interest using different approaches that will be presented in the discussion section. As shown in **Figure 1** below, the PRISMA guidelines were used to screen and select articles.

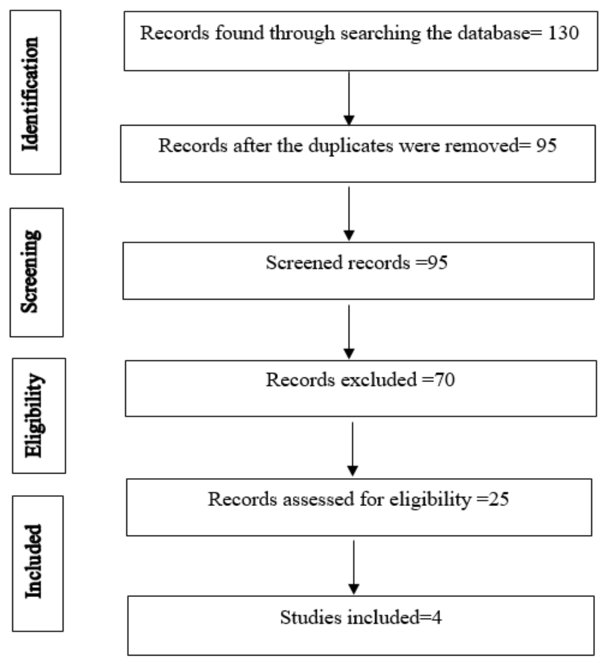

Figure 1. Eligibility criteria for inclusion and exclusion according to PRISMA guidelines

Bias Risk Assessment

To determine whether there was any form of bias in the selected studies, the Cochrane risk of bias assessment tool was used. This tool is crucial in assessing the risk of bias in randomized trials by concentrating on different aspects of reporting, conduct, and trial design. The rationale for using the Cochrane risk of the bias assessment tool is to evaluate the validity of the outcomes by examining how the study was conducted. The five domains that the tool utilizes include performance, selection, reporting, attrition, and other bias. **Tables 1 and 2** below display the Cochrane risk of a bias assessment tool and the overall risk of biased judgment respectively.

Table 1. Cochrane Risk of bias assessment

Domain	Description	High risk of bias	Low risk of bias	Unclear risk of bias	Reviewer assessment

Selection bias **Random sequence generation**	Expounds on the strategies leveraged to create allocation sequence to find out whether analogous clusters should be formed.	There is selection bias if there is not enough generation of random sequences.	Similar clusters should be produced for random sequence generation.	If selection bias is not addressed using enough details.	Judgment
Selection bias **Allocation concealment**	Whether strategies used to conceal allocation defined	Selection bias is present if there is insufficient concealment.	The likelihood of not anticipating intervention allocations	Not enough details	Judgment
Reporting bias **Selective reporting**	Should discuss how selective outcome reporting was assessed	Reporting bias is present if there is selective outcome reporting.	No reporting bias	Insufficient details	Judgment
Other bias	Any other matters associated with bias are not mentioned.	Bias fears as a result of concerns not dealt with in other areas	Other biases not present	Not enough information to disclose other bias	Judgment

Table 2. The overall risk of bias judgment

Study	Risk of bias judgment	Justification
Shah *et al*. (2021) [5]	Low risk of bias	No detection of any form of bias for the study.
Safwat *et al*. (2021) [7]	Low risk of bias	No form of bias can be detected in the article.
Kırmalı *et al*. (2021) [8]	Unclear risk of bias	Not enough details to reveal selection, reporting, and other biases.
Brożek, *et al*. (2019) [9]	Unclear risk of bias	Selection and reporting bias was not spotted in the study.

Results and Discussion

As shown in the PRISMA guidelines above, the employed search strategy yielded a total of 130 studies. Among these 130, the exclusion and inclusion metrics were applied to identify articles that could qualify for review. The first step was to remove the duplicates, a process that saw 35 articles excluded, leaving 95 studies for screening., The titles of the 95 articles were screened, a procedure that led to the further exclusion of 70 articles. The remaining 25 articles were assessed for eligibility, yielding 4 articles that were included in the review. The included articles addressed glass fiber-reinforced composite. Those excluded did not meet the set criteria for selection such as not having access to full texts. The four picked articles provided comprehensive information about glass fiber-reinforced composite restoration and its efficacy compared to other restoration materials. **Table 3** below displays a summary of the included studies.

Table 3. A summary of the studies

Author and year	Inclusion criteria	Findings
Shah *et al*. (2021) [5]	Addressed fiber-reinforced composite	Short fiber-reinforced composites and polythene fibers exhibited greater fracture resistance
Safwat *et al*. (2021) [7]	Addressed glass fiber-reinforced composite	The composition, length, amount, and distribution of glass fiber determine its success.
Kırmalı *et al*. (2021) [8]	Addressed glass fiber-reinforced composite	Glass fiber-reinforced composite can be used to restore endodontically treated teeth.
Brożek, *et al*. (2019) [9]	Focused on fiber-reinforced composites	Fiber-reinforce components can be used in place of prosthetic restorations due to their long-term effectiveness.

The studies revealed the strong and weak points of glass fiber-reinforced composite restoration. Mangoush *et al*. (2021) conducted a study to establish the effectiveness of fiber-reinforced composites and found that these materials are superior to non-fiber-reinforced composite restorations based on fracture strength [10]. Comparing glass and polyethylene fiber-reinforced composite restoration revealed that despite all being associated with the increase in fracture strength, continuous or short fiber-reinforced composites exhibited similar or better outcomes. However, Shah *et al*. (2021) reveal that the increased fracture resistance cannot be compared to that of an intact tooth [5]. Shah *et al*. (2021) concluded that short-reinforced and polyethylene composites exhibited better fracture resistance compared to glass fiber-reinforced composites [5].

On their part, Safwat *et al*. (2021) examined the advantages of glass fiber-reinforced composite as a dental material [7]. The authors established that the composition, amount, distribution, orientation, adhesion, and length of the glass fiber is what determines the success of glass fiber-reinforced composites. In tooth restoration applications, Safwat *et al*. (2021) assert that glass fiber-reinforced composites, precisely short glass fibers, have a positive impact when used in bulk and posterior composite restorations [7]. In support of glass fiber-reinforced composites, Brożek *et al*. (2019) highlight that the materials reinforced with fiberglass are stiff compared to those reinforced with aramid or polyethylene fibers [9]. Sáry *et al*. (2019) evaluated the resistance of the fracture of different restorative methods that utilized diverse fiber-reinforced materials in the restoration of deep class II MOD cavities for a molar [11]. The authors established that a combination of bidirectional and short glass fibers, as well as polyethylene fibers, restored the fracture resistance of the molar teeth.

Kırmalı *et al*. (2021) posit that the most significant characteristics of glass fiber-reinforced composite posts are their elastic modules that relate closely to that of dentin [8]. However, the writers acknowledge that since the glass fiber-reinforced composite posts are considerably composite materials, it is expected that their mechanical properties increase with a rise in the content of the fiber. Regarding compatibility, Wang *et al*. (2021) describe the concept as a property that means that medical devices or materials in direct contact with living tissues are compatible [12]. Therefore, Wang *et al*. (2021) highlight that E-glass fibers are the most appropriate for glass fiber-reinforced composites due to their compatibility [12].

On the other hand, Bazli *et al*. (2021) established that some advantages of glass fiber-reinforced polymer composite include a high ratio of stiffness-to-weight and high strength [13]. Dheepika (2020) compared the flexural strength of continuous S glass and E glass fibers reinforced with composite resin. The results indicated that overall, reinforcing composite resin with glass fibers substantially increases flexural strength [14]. However, the author concluded that the group that was reinforced with S glass recorded a superior flexural strength than that of the E glass in the experiment conducted. Patnana *et al*. (2020) assessed the fracture resistance of different filler composites, including glass-fiber-reinforced composites using different failure patterns and fracture types [15]. The authors concluded that polythene and glass-reinforced composites exhibited enhanced fracture resistance properties compared to traditional particulate filler composites [15].

Mena-Álvarez *et al*. (2020) concluded in their study that the fracture resistance of endodontically upper premolar tooth whose restoration was done with glass fiber-reinforced posts recorded increased fracture strength [16]. ManHart (2021) also applauds glass fiber-reinforced composites, asserting that they have satisfactory biochemical properties [17]. Singh *et al*. (2019) note that the fiber-reinforced composite is crucial in the dental profession even in dealing with posterior teeth [18]. Purayil *et al*., (2020) assert that the toughness and rigidity of dental composites is their greatest strength [19].

Conclusion

The systematic review has revealed that glass fiber-reinforced composite is vital in the restoration process of the tooth. Other materials can also be applied in the restoration endeavor, with fiber-reinforced composite exhibiting better clinical outcomes. The reviewed articles have shown that glass fiber-reinforced composite has been applied widely in clinical settings, with a majority of the resources agreeing that the efficacy of this material cannot be doubted.

ACKNOWLEDGMENTS: We would like to acknowledge the help of Riyadh Elm University research center.
CONFLICT OF INTEREST: None
FINANCIAL SUPPORT: None
ETHICS STATEMENT: This study fulfils the ethical requirements of Riyadh Elm University.

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