MedNEXT
Journal of Medical an Health Sciences

REVIEW ARTICLE

DOI: 10.54448/mdnt24306

Main clinical approaches to the use of silane in restoration repairs with resin: a systematic review

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DOI: https://doi.org/10.54448/mdnt24306

Received: 05-19-2024; Revised: 07-28-2024; Accepted: 08-10-2024; Published: 08-28-2024; MedNEXT-id: e24306

Editor: Idiberto José Zotarelli Filho, MSc., Ph.D., Post-Doctoral.

Abstract

Introduction: The repair in the composite clinical procedure is handy and allows the removal of the damaged portion of the restoration without requiring complete replacement of the same, allowing the preservation of sound tooth structure. **Objective:** The objective of this study was to review the literature evaluating the use of silane in repairs of composite resin restorations and the procedures to be followed. **Methods:** The PRISMA Platform systematic review rules were followed. The search was carried out from January to March 2024 in the Scopus, PubMed, Science Direct, Scielo, and Google Scholar databases. The quality of the studies was based on the GRADE instrument and the risk of bias was analyzed according to the Cochrane instrument. **Results and Conclusion:** A total of 117 articles were found, 43 articles were evaluated in full and 36 were included and developed in the present systematic review study. Considering the Cochrane tool for risk of bias, the overall assessment resulted in 07 studies with a high risk of bias and 21 studies that did not meet GRADE and AMSTAR-2. Most studies did not show homogeneity in their results, with X^2=74.5%>50%. In the literature review was noted that the preference for maintaining part of the restoration and repair of the clinical protocol should be thoroughly evaluated and implemented to increase the predictability of the procedure. The restorative material should unite, not only to tooth structure but also already present in the resin preparation. Thus, silanes and resins without charge are traditionally used as coupling agents in repairs. The advantages of this procedure compared with total replacement, and the possibility of obtaining a good integrity and longevity of the restoration involved were discussed. It was concluded that the adhesion between the existing and the new resin increment of resin can be enhanced by employing a silane, associated or not with an adhesive system.

Keywords: Composite Resin. Silane. Repair Restoration. Aesthetic.

Introduction

The use of composite resin in restorative dentistry has become routine with the improvement of adhesive systems, polymerization mechanisms, and improve the physical and mechanical properties of the resin systems. Thus, there was a multiplication of aesthetic restorations due to the relentless pursuit of beauty. According to the authors, composite resin has an average life of six years [1,2].

A treatment plan should be developed to always strive for the prevention of tooth structure, the patient's oral health, and good sense. Where the restorative treatment has already been designated and the restoration has some failure or malfunction, before it is replaced, it should evaluate the possibility of a repair. Repairs and re-sealings are alternatives to the full

replacement of restorations for the preservation of tooth structure. Recent studies have confirmed that the two larger restoration replacement causes are secondary cavities (± 50%) and fractures (± 25%) [3-5].

Also, repair provides less wear of healthy dental structures, minor weakening of the remaining dental pulp, and fewer injuries, and increases the longevity of the restoration in a less clinical time and with lower cost [6-10]. But one of the big questions about the use of the repair technique is, if, after the use of the same, you can get a good integrity and longevity of the restoration involved [11-13].

This is because the surface of a fractured restoration in composite resin is formed by an organic matrix already cured, thereby being a less reactive form [14-16]. Moreover, a composite resin restoration fractured invariably an inorganic phase with the presence of filler particles which can often be without the silane coating, which prevents the formation of chemical bonds with the new resin layer [15-17].

Another aspect to be noted is that, often, the dentist does not know the resin composition that was used in the making of the original restoration [4,18,19]. This is important because, it can influence the aesthetic appearance of the restoration due to the difference in color, texture, and brightness, as well as the ultimate strength of the repaired restoration [1-3].

Given this, the objective of this study was to conduct a literature review evaluating the use of silane restoration repairs with composite resin and the procedures to be followed.

Methods

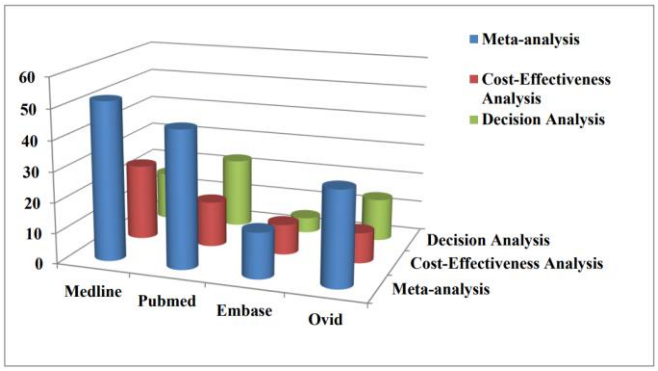
Study Design

The present study followed the international systematic review model, following the rules of PRISMA (preferred reporting items for systematic reviews and meta-analysis). Available at: http://www.prisma-statement.org/?AspxAutoDetectCookieSupport=1. Accessed on: 03/15/2024. The methodological quality standards of AMSTAR-2 (Assessing the methodological quality of systematic reviews) were also followed. Available at: https://amstar.ca/. Accessed on: 03/15/2024.

Data Sources and Research Strategy

The literary search process was carried out from January to March 2024 and was developed based on Medline, PubMed, Embase, and Ovid, covering scientific articles from various to the present, according to quantitative data on the types of works found about silane in restoration repair with composite resin in four databases (Figure 1). The descriptors (DeCS / MeSH Terms) were used: *"Composite Resin. Silane. Repair Restoration. Aesthetic"* and using the Boolean "and" between the MeSH Terms and "or" between descriptors.

Figure 1 - Quantitative data on the types of works found concerning silane in restoration repair with composite resin in four databases.



Study Quality and Risk of Bias

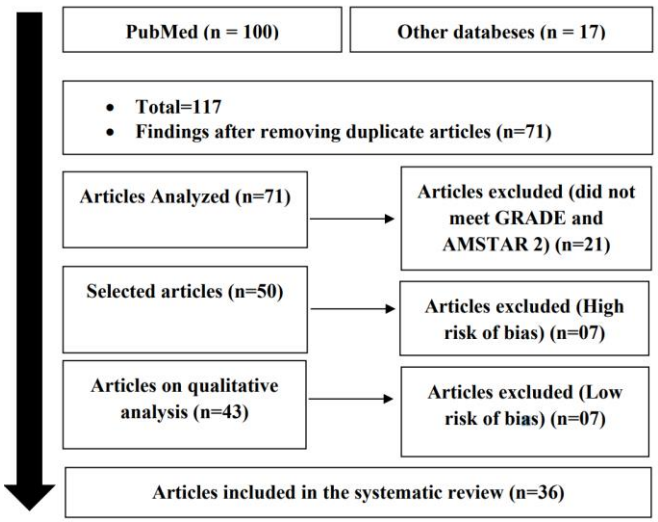
Quality was classified as high, moderate, low, or very low in terms of risk of bias, clarity of comparisons, precision, and consistency of analyses. The most evident emphasis was on systematic review articles or meta-analyses of randomized clinical trials, followed by randomized clinical trials. The low quality of evidence was attributed to case reports, editorials, and brief communications, according to the GRADE instrument. The risk of bias was analyzed according to the Cochrane instrument by analyzing the Funnel Plot graph (Sample size versus Effect size), using the Cohen test (d).

Results and Discussion

Summary of Findings

A total of 117 articles were found that were subjected to eligibility analysis, with 39 final studies being selected to compose the results of this systematic review. The studies listed were of medium to high quality (Figure 2), considering the level of scientific evidence of studies such as meta-analysis, consensus, randomized clinical, prospective, and observational. The biases did not compromise the scientific basis of the studies. According to the GRADE instrument, most studies showed homogeneity in their results, with X^2=74.5%>50%. Considering the Cochrane tool for risk of bias, the overall assessment resulted in 15 studies with a high risk of bias and 31 studies that did not meet GRADE and AMSTAR-2.

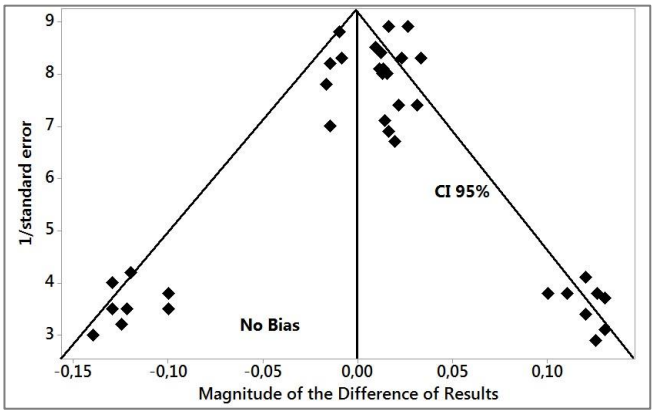
Figure 2. The article selection process by the level of methodological and publication quality.



Source: Own authorship.

Figure 3 presents the results of the risk of bias of the studies using the Funnel Plot, showing the calculation of the Effect Size (Magnitude of the difference) using the Cohen Test (d). Precision (sample size) was determined indirectly by the inverse of the standard error (1/Standard Error). This graph had a symmetrical behavior, not suggesting a significant risk of bias, both between studies with a small sample size (lower precision) that are shown at the bottom of the graph and in studies with a large sample size that are presented at the top.

Figure 3. The symmetric funnel plot suggests no risk of bias among the small sample size studies that are shown at the bottom of the graph. High confidence and high recommendation studies are shown above the graph (n= 36 studies).



Source: Own authorship.

Major Clinical Findings

When localized failures are observed in the restoration, the decision to make the replacement of the entire restoration or repair it is a challenge faced by many professionals in clinical practice. Thus, the dentist must apply specific criteria and well defined to decide the best treatment proposed for each case, whether repair or replacement. These criteria should involve mechanical, functional, biological, and/or aesthetic [1-3].

Thus, the total removal of restoration is accompanied by the removal of tooth structure that extends the cavity preparation, with more loss of healthy tooth structure [4]. Rather, a direct repair is a more conservative alternative that can prolong the existing restoration. The reconstructive techniques are employed for small surface irregularities of corrections, marginal carious lesions, and discoloration. If an adequate bond between the existing composite resin in the cavity and insertion can be achieved, repair restoration becomes an attractive solution [5].

Before considering the repair techniques, we should consider changes in the composites in the oral environment to understand the changes in their composition and their influence at the time of repair [2]. According to Bektas et al. (2012) [20], the bond strength between the old composite resin and resin added to the repair is influenced by the surface roughness of union materials and aging time.

The restorative material should join not only to tooth structure but also the resin already present in the restoration [3]. Stringent changes in the composite during the aging process, which may influence the success of the repair procedure, such as water absorption and chemical degradation [5]. The repair process may be more complicated in an old composite resin restoration, because the amount of remaining carbon double bonds decreases with time, decreasing the bond strength between the different increments [1,3]. The effects of pH changes, salivary enzymes, and humidity of the environment degradation of the composites are extensively reported in the literature [6].

Special attention should be given to the diffusion of water through the polymer chains and interfaces with the load and the hydrolytic deterioration of the polymer chains [1]. This complex mechanism of degradation can eventually result in the loss of components and the "plasticization" of the resins. Initially, this process may affect the surface properties, such as hardness and wear resistance [3]. However, the passage of time can interfere with the properties of the inorganic filler particles, such as the fracture resistance of the material, compromising the longevity of the restoration [13]. Furthermore, the intensity of this aging process affects restoration performance also depends on the microstructure characteristics and the composition of resins [20-24].

These characteristics vary from one brand to another but can be important in determining the effectiveness of surface treatment to repair composite resin restorations [25-28]. Various surface treatments

and binding agents can be used to improve the union between increments during repair [20]. The conditioning of dental materials increases the surface energy and can be based on chemical bonding with the matrix, with mechanical retention of exposed particles and micromechanical retention caused by the penetration of the monomer component in micro-irregularities [4]. In general, the conditioning of the surface of dental materials is the treatment by which the surface energy may be increased. Thus, the two treatments are possible to raise the surface energy of the material to be repaired: chemical conditioning or fitness (mechanical) / chemical [2].

Regarding the chemical union, silanes and uncharged resins are traditionally used as bonding agents in repairs. The separate application of a silane agent and a fluid resin (adhesive) can result in a thick interfacial layer, which can produce defects in this repair phase [29-31]. Some steps are important for the realization repair in the composite. Isolation prevents contamination with saliva making the tooth surface less favorable to adhesion, it promotes and provides the penetration of glycoproteins present in saliva [24]. The presence of salivary proteins can prevent the penetration of monomers in the enamel pores, and the network of collagen dentine after acid etching, reducing the restoration of the bond strength [25].

To carry out mechanical surface preparation is necessary to use diamond burs médium-grained blasting with aluminum oxide to remove the resin surface possibly deteriorated and increase the surface energy [2,32]. It can be used as a cleaning agent before starting the bonding procedures, as well as the use of conditioning with phosphoric acid 37% to remove organic contamination and residues left by mechanical treatment [12].

Also, phosphoric acid exerts its function only in cases where the repair involves dental tissue. The application of bonding agents can be done in three ways, just applying the silane agent; applying the silane agent and the adhesive system (Bond); and only applying the adhesive [3] system. silane is a coupling agent between inorganic materials and organic materials. Are bifunctional molecules in which the functional radicals silico-unite the silicas of the acid-sensitive porcelain or glass fiber pins and organo-functional radicals polymerize with the organic matrix of resin cements (methacrylates). They are also called "ceramic primers" or "bonding agents" [33-36].

The adhesive is who promotes a chemical bond with the organic matrix of the composite resin, and the intermediate agent of union between the repair and the resin to be repaired. The composite resin to be used should be applied, choosing the appropriate material for each case [2]. Some work, analyzing the relevance of various chemical and mechanical treatments in old composite resins and repair bond strength, concluded that the improvement in the bond strength between the new and the old composite resin restoration requires increased harshness to institute micromechanical union between the surface of the old composite resin and the resin together [5].

Besides, resin surface roughness was an essential element in increased repair strength. The wear of the bonding surface of the composite cracked down on repair bond strength because the charged particles are in evidence. Eli et al. (1988) [14] reported that it was not acceptable clinically increase in repair union by the resin surface irregularity. Sobreira et al. (2008) [26] found that the combination of phosphoric acid/silane proved to be the most effective procedure for repairs increased resistance. Some studies report that the conditioning, the surface of the composite to be repaired with phosphoric acid at 37%, has only a cleaning function, it produces no irregularities and asperities as in enamel and dentin [2,3]. In 2009, Rathke et al. [15] found that the wear of the resin surface with diamond-sized particles of 107 micrometers followed by conditioning by 34.5% phosphoric acid for the 20s, showed a reduction in repair of bond strength about blasting with aluminum oxide 50 um.

Moreover, blasting with aluminum oxide 50 microns produced an average of deeper surface roughness (15 mM), with the trend of increased repair bond strength compared to sandblasting with aluminum oxide coated silica (30 mM), resulting in an average of 10 micrometers surface roughness, when analyzed by scanning electron microscopy [11]. The surface treatment based on sandblasting (aluminum oxide, and silica coating) produces a resin of higher average values in bonding strength of the repairs, whether the primer used (silane adhesive or a combination of both). The microstructure of the resins influences the average values of the bond strength, higher for micro-hybrid resin compared to the nanoparticle [13].

Adhesive treatment performed after the mechanical preparation of the surface also has a significant effect on the bond strength of repair. The general trend is that the adhesive to increase the bond strength due to internal flow and external leveling of mechanical micro-retentions [11]. The conditioning of the repair surfaces with silane use before application of the adhesive material, with or without the use of phosphoric acid at 37%, is recommended to improve the repair bond strength [5].

It can be observed that there is agreement in the literature regarding the benefits of repair-indicated composite resin when compared to the complete

replacement of unsatisfactory restoration [1-3]. Please note that the repair technique indication must take into account not only the detection of the fault to be repaired but also the good condition of the remaining resin and the advantages of conservation [3]. The guidelines to the patient for proper oral hygiene maintenance are essential to ensure the longevity of the restoration, avoiding the main reasons for the subsequent failure of the technique, such as dental fracture and secondary caries, reported by Demarco et al, (2012) [25].

Conclusion

It was concluded that the adhesion between the existing and the new resin increment of resin can be enhanced by employing a silane, associated or not with an adhesive system.

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Author contributions: **Conceptualization -** Lailla Aparecida Gonzaga, Ana Júlia de Campos Borges, Ana Flávia Venâncio, Andreia Borges Scriboni; **Data curation -** Lailla Aparecida Gonzaga, Ana Júlia de Campos Borges, Ana Flávia Venâncio; **Formal Analysis -** Andreia Borges Scriboni; **Investigation -** Lailla Aparecida Gonzaga, Ana Júlia de Campos Borges; **Methodology -** Ana Júlia de Campos Borges, Ana Flávia Venâncio; **Project administration -** Andreia Borges Scriboni; **Supervision -** Andreia Borges Scriboni; **Writing - original draft -** Lailla Aparecida Gonzaga, Ana Júlia de Campos Borges, Ana Flávia Venâncio; **Writing-review & editing -** Lailla Aparecida Gonzaga, Andreia Borges Scriboni.

Acknowledgment

Not applicable.

Ethical Approval

Not applicable.

Informed Consent

Not applicable.

Funding

Not applicable.

Data Sharing Statement

No additional data are available.

Conflict of Interest

The authors declare no conflict of interest.

Similarity Check

It was applied by Ithenticate®.

Peer Review Process

It was performed.

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