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ANTIBACTERIAL ACTIVITY OF SILVER IONS WHEN INCORPORATED IN FILTERS OF COMPOSITES FOR SECONDARY CARIES PROTECTION- A SYSTEMATIC REVIEW

Elakiya S[1], Dinesh Dhamodhar[2] , Prabu D[3], Rajmohan M[2], Bharathwaj V V[4], Sindh R[4] , Gousalya V[1]

[1]*Postgraduate student, Department of Public Health Dentistry, SRM dental college, Ramapuram, Chennai, India*

[2]*Reader, Department of Public Health Dentistry, SRM dental college, Ramapuram, Chennai, India*

[3]*Professor and Head of the Department, Department of Public Health Dentistry, SRM dental college, Ramapuram, Chennai, India*

[4]*Senior Lecturer, Department of Public Health Dentistry, SRM dental college, Ramapuram, Chennai, India*

Corresponding Author: ***Prabu.D,Master of Dental Surgery, Professor and Head of the Department, Department of Public Health Dentistry,SRM Dental College, Ramapuram, Chennai-600089, Tamilnadu, India***

ABSTRACT

To determine the antibacterial activity of silver ions while incorporating with filters of composite resins for the protection of secondary caries. A systematic review was conducted based on a literature search using the search keywords (antibacterial activity) AND (composite resin) AND (secondary caries). An in-vitro study investigating the antibacterial activity of silver ions while incorporating composite resins for the protection of secondary and further followed by Cochrane database bias assessment was done. Eight in-vitro studies were included. The results of all eight studies were statistically significant with the antibacterial activity of silver ions with composite resins and protection of secondary caries. This study concludes that there is an effective antibacterial activity of silver ions while incorporated with the composite filling for the protection of secondary caries. All the study concludes there is a significant between the protection of secondary caries while filled with composite resin and antibacterial activity.

KEYWORDS: ***Dental caries, composite resin, antibacterial activity, silver ion, antibacterial agents.***

INTRODUCTION

Dental caries is an infectious disease of bacterial Etiology (1). Although several species of bacteria have been isolated from dental plaque associated with caries lesions, there is evidence that Streptococcus mutans, Streptococcus sobrinus, and lactobacilli are the major human dental pathogens (2). Over long periods of time, resin composite restorations tend to accumulate more bacteria and dental plaque than enamel surfaces in vitro (3, 4) and in vivo (5), resulting in secondary caries around them. The possibility of recurrent caries increases with greater amounts of dental plaque accumulation on restorative materials. Caries rarely occur adjacent to glass ionomer restorations. On the other hand, caries around glass ionomer restorations occurred in a clinical follow-up study in rather high frequencies (6). SVANBERG et al. (7) demonstrated that the in vivo growth of oral streptococci was inhibited around silver-containing glass ionomer cement. This may have been due to silver ions released from the materials (8, 9). Silver has been used for a long time as an antimicrobial agent (10). Resin composites containing silver ion-containing, which release silver ions, have been found to have antibacterial effects on oral streptococci (11). Attempts have been made to prevent plaque accumulation on the surfaces of restorative materials by incorporating antibacterial agents such as chlorhexidine (12). Although initially strong, this antibacterial effect did not last long antibacterial agents such as chlorhexidine or antibiotics in methacrylate or other restorative materials affected their mechanical properties (13). Moreover, the release of these antibacterial agents resulted in further changes in the physical properties of the materials (14). To overcome these disadvantages, IMAZATO et al. (15) recently incorporated a non-releasing synthesized monomer with antibacterial properties in a resin composite. Other antibacterial materials, including silver ions in inorganic oxides as a carrier, have been developed. To give two examples of their methods of synthesis, silver ions may be hydrothermally supported into the space between the crystal lattices of network-structured zirconium phosphate, or silver complexes may be supported into a silica gel, and then thin sol-gel-derived silica is coated on its surface by a dipping method (16). Such materials have been shown to exhibit strong antimicrobial activity against Gram-positive and Gram-negative bacteria, yeast, and molds (17). For resin composites incorporating antibacterial agents into the resin part, these materials may solve the problem of the short-term durability of antibacterial activity and deterioration of the mechanical properties. In this study, we assessed the antibacterial activity against mutans Streptococci

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of light-activated resin composites incorporating one of the three types of silver-containing materials into SiO2 and measured the amounts of silver ions released from the composites. In addition, we also investigated the influence of the incorporation of silver-containing materials on the mechanical properties of resin composites. The aim of the study is to determine the antibacterial activity of silver ions while incorporating filters of composite resins for the protection of secondary caries.

MATERIALS AND METHODS

A total of 120 articles were searched using among those 8 articles included in this study, and this systematic review was done using composite for caries protection.

ELIGIBILITY CRITERIA

Inclusion Criteria

1. Studies published in English
2. Articles on the composite with antibacterial activity
3. Full-text articles
4. In- vitro studies

Exclusion criteria

1. Only abstracts available
2. Unrelated articles
3. Animal studies
4. RCT studies

SEARCH ENGINES

PubMed
Wiley online library
Cochrane library
Elsevier science direct
Prospero
Cinahl
Scopus
OSF
Ovid Medicine
Grey literature

After the search using the appropriate mesh terms, a total of 120 articles were found from the online databases. After duplicates removal, 109 articles were screened, and 99 full-text articles were available. Inclusion-exclusion criteria were applied, and finally, 8 related articles were selected for further assessment**.**

RESULTS

TABLE 1: shows the characteristics of the intervention in the included studies.
TABLE 2: shows an outcome and result of the composite in caries protection in the above-mentioned studies.
TABLE 3: shows the bias analysis of all the included studies. It is categorized as high-risk bias "-", low-risk bias "++" and unclear "?".

DISCUSSION

Silver has been used for a long time in medicine as an antimicrobial agent (10). The inhibitory effect of three silver-containing materials against S. mutans seen in this study was probably due to direct contact with S. mutans (17) and not to silver ion release because they were insoluble in the culture media, and there was no release of silver ions from the composites.

Yoshida et al. 1999, a totally of 5 samples were used in this study, and the antibacterial activity found here was Streptococcus mutans. It is an in-vitro study here; the material used was Novaron (N), Amenitop (AM), and AIS, and it has a concentration of 5% Wt, 7% Wt, and 10% Wt. the intervention used is TEGDMA-UDMA-based light-activated resin composites, and the outcome shows light-activated resin composite incorporating silver-containing materials such as Novaron may be clinically useful due to its long-term inhibitory effect against S. mutans and favorable mechanical properties, and the p-value is $P<0.01$ which is statistically significant (18).

Shahin kasraei et al. 2014, a totally of 30 samples were used in this study, and the antibacterial active found here were Streptococcus mutans and Lactobacillus. It is an in-vitro study, here, the material used was nano-silver and 1% nano zinc oxide, and it has a concentration of1% and 1%. The intervention used is flowable composite resin, and the outcome shows that light-activated resin composite incorporating silver-supported antibacterial material such as Novaron may be clinically useful due to its inhibitory effect against S. mutans and favorable mechanical properties, and the p-value is $P<0.05$, which is statistically significant(19).

Mojgan kachoei et al. 2021, a totally of 30 samples were used in this study, and the antibacterial active found here were Streptococcus mutans, Lactobacillus and Candida albicans. It is an in-vitro study, here, the material used was ZnO nanoparticles and silver ions nanoparticles, and it has a concentration of 5% and 5%. The intervention used is composite resin, and the outcome shows Incorporation of ZnO nanoparticles and their compounds into orthodontic composite resins induced antibacterial properties against oral pathogens, and of all these nanoparticles, the AZ group exhibited the best antimicrobial activity and highest shear bond strength, and the p-value is $P<0.05$ which is statistically significant (20).

Xanthippi chatzistavrou et al. 2018, a total of 24 samples were used in this study, and the antibacterial activity found here was Streptococcus mutans. It is an in-vitro study; here, the material used was Ag-doped sol-gel derived bioactive glass, and it has a concentration of 5, 10, and 15 wt.%. The intervention used is flowable composites, and the outcome shows new resin composites with antibacterial and remineralizing properties and new resin composites with antibacterial and remineralizing properties, and the p-value is $P<0.05$, which is statistically significant (21).

Tanagawa et al. 1999, a totally of 7 samples were used in this study, and the antibacterial activity found here was Streptococcus mutans. It is an in-vitro study here; the material used was Novaron (N), Amenitop (AM), and AIS, and it has a concentration of 5% Wt, 7% Wt, and 10% Wt. the intervention used is TEGDMA-UDMA-based light-activated resin composites, and the outcome shows light-activated resin composite incorporating silver-containing materials such as Novaron may be clinically useful due to its long-term inhibitory effect against S. mutans and favorable mechanical properties, and the p-value is $P<0.01$ which is statistically significant (22).

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Mohadese azarsina et al. 2013, a totally of 36 samples were used in this study, and the antibacterial active found here were Streptococcus mutans and Lactobacillus. It is an in-vitro study, here, the material used was Nanosilver, and it has a concentration of0.5 and 1% weight. The intervention used is composite resin, and the outcome shows Addition of silver nanoparticles to Z250 composite could significantly inhibit the growth of Streptococcus mutans and Lactobacillus on the surface of this composite, and the p-value is P=0.001 which is a statistically significant (23).

Robert stencel et al., a totally of 5 samples were used in this study, and the antibacterial activity found here was Streptococcus mutans. It is an in-vitro study here; the material used was silver sodium hydrogen zirconium phosphate, and it has a concentration of 1%, 4%, 7%, 10%, 13%, and 16% Wt. the intervention used is composite resin, and the outcome shows composites exhibited properties similar to the control material and enhanced in vitro antimicrobial efficiency and the p-value is P=0.0002 which is statistically significant (24).

Tejas barot et al. 2020, a total of Six groups of experimental resin composite samples were made: one control group was used in this study, and the antibacterial activity found here was Streptococcus mutans. It is an in-vitro study here; the material used was Halloysite Nanotubes, and it has a concentration of 7.5 and 10 wt. %. The intervention used is Bis-GMA/TEGDMA dental resins composites, and the outcome shows HNT/Ag containing dental composite is proposed to be highly valuable in the development of restorative dental material for patients with a high risk of dental caries, and the p-value is P<0.05 which is statistically significant (25).

CONCLUSION

This study concludes that there is an effective antibacterial activity of silver ions while incorporated with the composite filling for the protection of secondary caries. All the study concludes there is a significant between the protection of secondary caries while filled with composite resin and antibacterial activity.

CONFLICT OF INTEREST: None
ACKNOWLEDGEMENT: Nil

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Figure 1: Flow Diagram Showing the Number of Studies Identified, Screened, Assessed for Eligibility, Excluded, and included in the Systematic Review

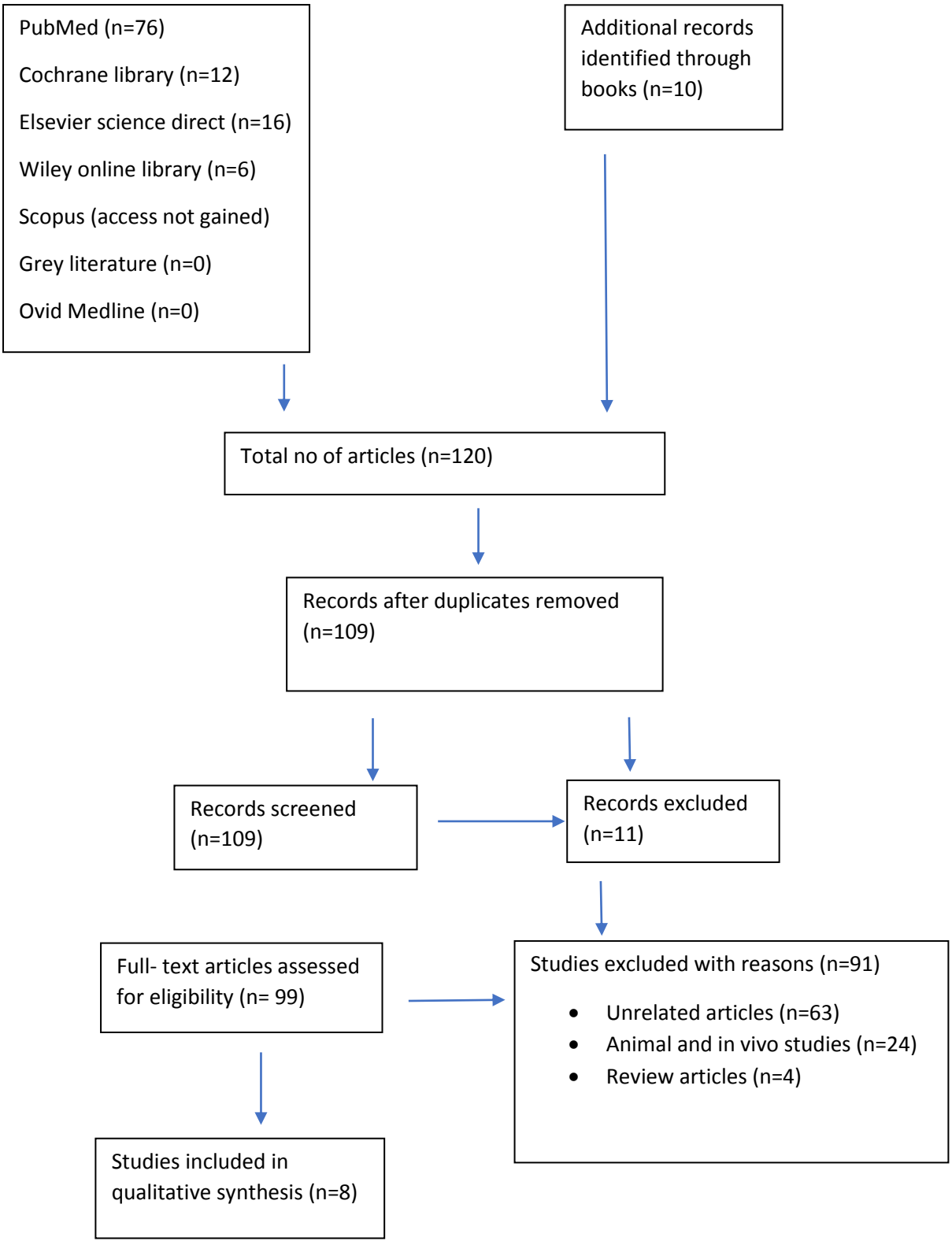

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TABLE 1: CHARACTERISTICS OF THE INTERVENTIONS IN THE INCLUDED STUDIES

Sl. No:	Author	Year	Bacteria	Materials	Concentrations Used	Intervention
1	YOSHIDA et al (18)	1999	Streptococcus mutans	Novaron (N), Amenitop (AM), and AIS	5% WT 7% WT 10% WT	TEGDMA-UDMA-based light-activated resin composites
2	SHAHIN KASRAEI et al (19)	2014	Streptococcus mutans and Lactobacillus	nano-silver and 1% nano zinc-oxide	1% 1%	flowable composite resin
3	MOJGAN KACHOEI et al (20)	2021	Streptococcus mutans, Lactobacillus and Candida albicans	ZnO nanoparticles and silver ions nanoparticles	5% 5%	Composite resin
4	XANTHIPPI CHATZISTAVROU et al (21)	2018	Streptococcus mutans	Ag-doped sol-gel derived bioactive glass	5, 10, and 15 wt.%	flowable composite
5	TANAGAWA et al (22)	1999	Streptococcus mutans	Novaron, Amenitop and AIS	5% WT 7%WT 10%WT	TEGDMA-UDMA-based light-activated resin composite
6	MOHADESE AZARSINA et al (23)	2013	Streptococcus mutans and Lactobacillus	Nanosilver	0.5 and 1% weight	composite resin
7	ROBERT STENCEL et al (24)	2018	Streptococcus mutans	silver sodium hydrogen zirconium phosphate	1%, 4%, 7%, 10%, 13%, and 16% Wt	composite
8	TEJAS BAROT et al (25)	2010	Streptococcus mutans	Halloysite Nanotubes	7.5 and 10 wt. %	Bis-GMA/TEGDMA dental resins composites

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TABLE2: OUTCOME DATA AS REPORTED IN INCLUDED STUDIES

1	YOSHIDA et al 1999 (18)	5 samples	In vitro study	light-activated resin composite incorporating silver-containing materials such as Novaron may be clinically useful due to its long-term inhibitory effect against S. mutans and favorable mechanical properties	P<0.01
2	SHAHIN KASRAEI et al 2014 (19)	30 samples	In vitro study	Composite resins containing silver or zincoxide nanoparticles exhibited antibacterial activity against Streptococcus mutans and Lactobacillus.	p < 0.05
3	MOJGAN KACHOEI et al 2021 (20)	30 samples	In vitro study	Incorporation of ZnO nanoparticles and their compounds into orthodontic composite resins induced antibacterial properties against oral pathogens, and of all these nanoparticles, the AZ group exhibited the best antimicrobial activity and highest shear bond strength.	P <0.05
4	XANTHIPPI CHATZISTAVROU et al 2018 (21)	24 samples	In vitro study	New resin composites with antibacterial and remineralizing properties new resin composites with antibacterial and remineralizing properties	p < 0.05
5	TANAGAWA et al 1999 (22)	7 samples	In vitro study	light-activated resin composite incorporating silver-supported antibacterial material such as Novaron may be clinically useful due to its inhibitory effect against S. mutans and favorable mechanical properties.	P<0.01
6	MOHADESE AZARSINA et al 2013 (23)	36 samples	In vitro study	Addition of silver nanoparticles to Z250 composite could significantly inhibit the growth of Streptococcus mutans and Lactobacillus on the surface of this composite.	p = 0.001

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7	ROBERT STENCEL et al 2018 (24)	Not mentioned	In vitro study	composites exhibited properties similar to the control material and enhanced in vitro antimicrobial efficiency.	p = 0.0002
8	TEJAS BAROT et al 2020 (25)	Six groups of experimental resin composite samples were made: one control group	In vitro study	HNT/Ag containing dental composite is proposed to be highly valuable in the development of restorative dental material for patients with high risk of dental caries.	p < 0.05

TABLE 3: BIAS ANALYSIS OF INCLUDED STUDIES

S. No	Author And Year	Random Sequence Generation	Allocation Concealment	Selective Reporting	Incomplete Outcome Data	Blinding Of Outcome Assessment	Blinding Participants And Personals
1	YOSHIDA et al 1999 (18)	++	-	++	++	++	-
2	SHAHIN KASRAEI et al 2014 (19)	++	-	-	++	++	++
3	MOJGAN KACHOEI et al 2021 (20)	++	-	++	++	++	?
4	XANTHIPPI CHATZISTA VROU et al 2018 (21)	++	-	++	++	++	?
5	TANAGAWA et al 1999 (22)	++	++	-	-	-	-
6	MOHADESE AZARSINA et al 2013 (23)	++	-	-	-	-	++
7	ROBERT STENCEL et al 2018 (24)	-	-	-	++	-	++
8	TEJAS BAROT et al 2020 (25)	-	-	++	-	++	-

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