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REVIEW PAPER OPEN ACCESS

Role Of Resin Infiltration for Enamel Development Defects and White Spot Lesions. A Systematic Review

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Abstract

Resin infiltration is one of the most advanced techniques used for the treatment of white spot lesions of enamel. In this technique, infiltration is performed through the application of resin to smooth surfaces of demineralized enamel. The objectives of this systematic review focused on resin infiltration for the treatment of enamel discolorations and white spot lesions. Data were searched from January 2000 to October 2022 by using keywords resin infiltration, white spot lesions, and enamel discoloration from PubMed, Google Scholar, Wiley, Taylor and Francis, Science Direct/Scopus, BMC, and Nature platforms. After screening duplicates and careful evaluation, only seven articles were selected to explore resin infiltration to treat enamel discolorations and white spot lesions. Although; the application of resin showed high efficacy in treating dental enamel defects and actively growing enamel lesions. Resin infiltration also reduces the demineralization cycle. It has been concluded that resin infiltration is an emerging technology; however, clinical evidence and trials lack the role of resin infiltration, and there is an urgent need for large-scale studies with a larger sample size with regular follow-up that explores the role of resin infiltration in dental therapy.

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Introduction

Tooth discoloration commonly occurs due to changing color of the whitish teeth. Conditions such as molar-incisor hypomineralization, fluorosis, and in some cases traumatic hypo calcification, increase the risk of enamel discolorations (Summitt *et al.*, 2006; Ogaard 2008). Enamel discolorations and white spot lesions resulting from enamel demineralization, affect the chemical composition and optical characteristics, and continuous damage to dental tissues (Sudjalim *et al.*; 2006, Akin *et al.,* 2012; Caeiro-Villasenín *et al.*, 2022).

Resin infiltration is the most advanced technique used for the treatment of white spot lesions of the enamel. In this technique, infiltration is carried out by the application of resin to smooth surfaces of demineralized enamel (Paris *et al.*, 2016; Alverson *et al.*, 2021). This infiltration in dental technology has several advantages such as maintaining the balance of the refractive index of dental tissues filled with water that has a refractive index (R=1.5) close to the refractive index (R=1.4) of infiltrated resin (Attal *et al.,* 2014; Tavares *et al.*, 2021; Alverson *et al.*, 2021). Previous *In vitro* studies revealed the safety and efficacy of resin application for enamel discoloration treatment. Recent studies revealed that resin possessing low viscosity showed excellent penetration rather than high-viscosity resin (Alverson *et al.*, 2021). Other clinical studies demonstrated that artificial caries models enhanced the color masking property of resin (Huang *et al.*, 2022). The objective of this study was to address the findings of the designed systematic review focused on resin infiltration for the treatment of enamel discolorations and white spot lesions.

Methodology

Strategic extensive data were explored for this systematic review's novel aspects and the following criteria were also kept in consideration for conducting a basis of the systematic review.

Search strategy

The data were searched from January 2000 to October 2022 by using keywords resin infiltration, white spot lesions, and enamel discoloration from PubMed, Google Scholar, Wiley, Taylor and Francis, ScienceDirect/Scopus, BMC, and Nature platforms.

Study selection

Data selection was carefully obtained from extensive searching via year and author names of publication and selected recently published articles and old literature.

It involves the latest advances in resin infiltration technique, risk factors associated with white skin lesions, and facts behind enamel discoloration.

Inclusion criteria

A designed criterion for this systematic review, including the published articles, cross-sectional or designed studies, case-control and cohort studies, and randomized clinical trials was used by including only pieces that were published in United States English.

Exclusion criteria

Some of the literature was excluded for exploring the innovative aspects of this systematic review. Articles that were written other languages other than US English language, letters to editors, epidemiological or prevalence studies, congress contributions, presentations, and conferences were excluded.

Data recording

The data for the current systematic review was recorded by the last name of the author and the year of publication. Several variables were included in data recordings, such as clinical dental resin infiltration technique, optical properties, white spot lesions, chemical composition, and enamel discoloration for this systematic review.

Results

Study design and selection criteria

Fig. 1 shows the searches of 100 articles in different databases. After careful screening of duplicates, 42 articles were finally selected. Finally, seven articles were eligible for this systematic review.

Table 1. The different characteristics of particularly selected studies.

Study type	Study design	Subjects' age mean ±SD (range) (yrs)	n	Lesion type	Follow up	Treatment
Hammad *et al.* 2012[12]	Non-randomized	14.5(1.4)	18	WSL/PO	Immediately	Resin Infiltration
Wang *et al.* 2013 [13]	RCT	17(11–25)	29	WSL/PO	5m	Resin Infiltration
Haddad *et al.* 2014 [14]	RCT	13(12–25)	85	WSL/PO	3m	Resin Infiltration
Gugnani *et al* 2015 [15]	RCT	16(14-25)	84	WSL/PO	6m	Resin Infiltration
Prajapati *et al.* 2017 (India) [16]	Non-randomize	12(14-25)	10	WSL/PO	510h	Resin Infiltration
López *et al.* 2019 (Brazil) [17]	RCT	11(14-25)	16	WSL/PO	0.5h	Resin Infiltration
El Meligy, 2021 (Saudi Arabia) [18]	RCT	14(14-25)	25	WSL/PO	388h	Resin Infiltration

Study characteristics

Table 2 shows the different characteristics of particularly selected studies. Five studies were non-randomized: two full texts and full-length articles. These studies were included in the follow-up discussions (Hammad *et al.*, 2012; Wang *et al.*, 2013; Haddad *et al.,* 2014; Gugnani *et al.*, 2015; Prajapati *et al.*, 2017; López *et al.,* 2019; El Meligy *et al.*, 2021). Each study comprised different participants, and details are given in Table 1.

Table 2. The methodological assessment carried out by using the tool such as the methodological Index for Non-Randomized Studies (MINORS).

Parameters of the study	Hammad *et al.* 2012 [12]	Wang *et al.* 2013 [13]	Haddad *et al.* 2014 [14]	Prajapati *et al.* 2017 (India) [16]	El Meligy, 2021 (Saudi Arabia) [18]
Data Collection	1	1	0	1	2
Patients history	1	0	2	0	1
Endpoint designed to Study Aim	1	2	1	1	2
Unbiased Level	1	1	1	0	1
Follow up study	2	1	0	2	0
Unfollow Study	0	0	1	0	1
Prospective sample size	1	1	0	1	0
Grand Total	7	6	5	5	7

2= Reported & adequate; 1 = Reported & inadequate; 0 = Un-reported.

Methodological Quality and Risk of bias within studies: Table 2 shows the methodological assessment carried out using the tool; Methodological Index for Non-Randomized Studies (MINORS):

This assessment cooperatively varied scores ranging from 0 to 7. All studies clearly showed the aim of the study, sample size, data collection, follow-up treatment, and outcomes. Among them, unbiased assessment is classified as blindness; two studies are considered moderate quality, and one is low quality. Table 3 shows the results of RCT studies and unreasonable risk assessments that were selected selective studies, random sequence data, particular sample size, blinding assessment, allocation dissimulations, and incomplete data due to inconsistency. While biased review shows the different signs indicated for - high risk, + low risk, and? for unclear. The complete description of studies of risk analysis is shown in Table 3.

Clinical features using resin infiltration

Figs 2, 3,4, and 5 show the different clinical features, and the description of each parameter shows the pathophysiological and anatomical findings; the resin application to white spot lesions, dental view after resin application; and dental view after one week of resin application.

Table 3. The biased assessment of selected studies.

Selective Studies	Hammad *et al.* 2012[12]	Wang *et al.* 2013 [13]	Haddad *et al.* 2014 [14]	Prajapati *et al.* 2017 (India) [16]	López *et al.* 2019 (Brazil) [17]	El Meligy, 2021 (Saudi Arabia) [18]
Random Sequence data	_	+	_	+	?	+
Blinding Assessment	+	?	+	_	?	+
Allocation Dissimulations	+	_	+		_	
Incomplete Data	?	_	_	+	?	+

While biased assessment shows the different signs indicated for - high risk; + for low risk; and? for unclear.

Discussion

Resin infiltration (RI) is one of the most promising techniques in the modern era widely used for the treatment of enamel discoloration and white spot lesions (WSLs) (Attia, 2018). RI is also used as an invasive approach due to its high penetration ability. Resins are applied in two forms: BisGMA (Bisphenol A Diglycidil Dimethacrylate) and TEGDMA (Triethylene Glycol Dimethacrylate). These resins offer low viscosity, which makes them ideal for dental therapy (Wong *et al.*, 2017). Results of the current systematic review revealed that the amount of sound enamel can be improved, and white spot lesions (WSLs) can be reduced by resin infiltration. Dietary acids and carbohydrates increase the formation of lesions on enamel, while saliva decreases the demineralizing process.

Resin-infiltration also improved the function of the teeth and undergoes the remineralization process as it initiates the repairing of dental tissues (Abou Neel *et al.*, 2016).

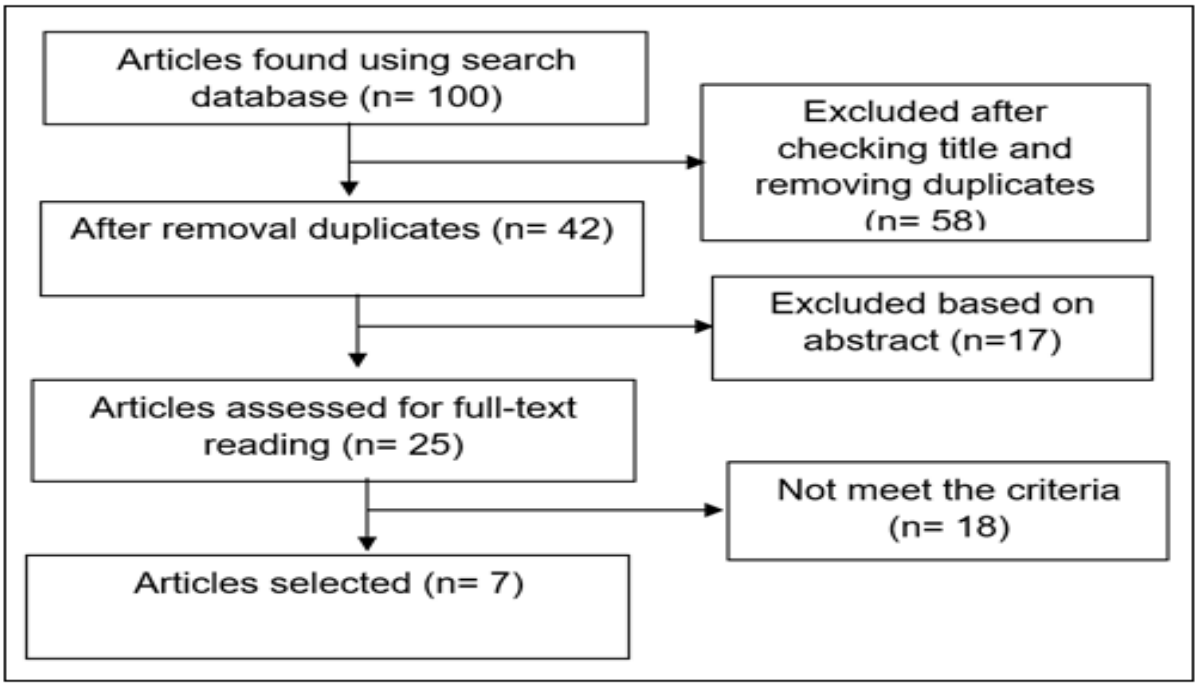

Fig. 1. Search strategy for related articles.

Studies revealed that microhardness is based on the deposition of calcium in dental tissues, and this parameter can be used for accessing the level of enamel porosity (Montasser *et al.*, 2015). A clinical trial investigated that resin infiltration increases calcium polymerization, thus promoting microhardness (Neres *et al.*, 2017). Results of this systematic review indicated that resin infiltration as invasive dental therapy regulates the microhardness of WSLs by 68%.

Fig. 2. The formation of white spot lesions before resin infiltration (Khatri *et al.*, 2022).

Fig. 3. The resin application to white spot lesions (Khatri *et al.*, 2022).

This result agreed with the previous systematic review that showed resin-treated patients with low viscosity maintained the calcium deposition and microhardness effectively compared to the non-treated samples (Zakizade *et al.*, 2020).

Fig. 4. The dental view after resin application (Khatri *et al.*, 2022).

Resin tags that possess low viscosity are impregnated with dental tissues and promote the healing process. Another study revealed that white spot lesions increased the risk of deterioration of dental tissues. These lesions are filled with resin with improved penetration ability (Theodory *et al.*, 2019). A recent clinical study revealed that enamel lesions filled with resins showed high penetration depth. The resin embedded with different materials allows them penetrate into the solid's tissues (Wang *et al.*, 2021).

Fig. 5. The dental view after one week of resin application (Khatri *et al.*, 2022).

Clinical studies showed that resin infiltration is more effective than clinical masking and had a positive effect on enamel development. Some randomized studies showed the clinical efficacy of resin infiltration, by cleaning the strength with resins. After one week of follow-up, promising results of applied resins were observed in treated patients. Other studies revealed that patients were treated with bleached fluorotic agents and resins. Results indicated that resin infiltrated the concave inner surface of dental enamel with esthetic improvements compared to bleaching treatments (Perdigão, 2020; Borges *et al.*, 2019).

Conclusion

The present systematic review demonstrates resin infiltration as an emerging and non-invasive dental approach for treating white spot lesions and defects during enamel development however, clinical evidence and trials lack the role of resin infiltration. In the future, there is an urgent need for large-scale studies with larger sample sizes and regular follow-ups that should explore the part of resin infiltration in dental therapy.

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Conflicts of interest
The authors declared no conflict with this systematic review.

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