

Application of Non-Invasive Methods in the Treatment of White Spot Lesions in Children: A Review Article

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Abstract

This comprehensive review of 25 studies on white spot lesion (WSL) treatment in children highlights the effectiveness of resin infiltration (RI) and the potential of casein phosphopeptide-amorphous calcium phosphate (CPP-ACP) as prominent treatment options. These findings are underscored by comparative studies, emphasizing the importance of long-term effects and age-specific considerations in treatment planning. The diversity in study types and diagnostic methods underscores the need for personalized approaches to WSL management. While common conclusions emerge, such as the efficacy of CPP-ACP and RI, contrasting findings remind us of the complexity of WSL management. The call for further research, particularly long-term studies, indicates the evolving nature of this field and the need for refining treatment protocols. Moreover, these studies emphasize the significance of conservative approaches, including regular oral hygiene practices and minimally invasive interventions, as integral components of a holistic WSL treatment strategy. (**International Journal of Biomedicine. 2023;13(4):228-235.**)

Keywords: white spot lesion • resin infiltration • casein phosphopeptide-amorphous calcium phosphate • fluoride-based treatment

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Abbreviations

CPP-ACP, casein phosphopeptide-amorphous calcium phosphate; **ICDAS II**, International Caries Detection and Assessment System II; **MID**, minimal intervention dentistry; **RI**, resin infiltration; **WSL**, white spot lesion.

Introduction

Dental caries, often known as tooth decay, is one of the most common chronic disorders afflicting people worldwide; people are susceptible to it throughout their lives.⁽¹⁾ The start

and progression of caries are determined by the balance of pathogenic and preventative factors.⁽²⁾ Dental caries is one of the most common diseases (approximately 50%) in children worldwide. If not treated in time, it can damage not only the mastication function, but also the child's speech, smile, and psychosocial environment, as well as the child's and family's quality of life. Dental disease treatment is quite expensive in all nations, and prevention is very easy and efficient.⁽³⁾

In November 2022, WHO reported 2.5 billion suffer from untreated caries.⁽⁴⁾ Several studies have reported the

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prevalence of white spot lesions (WSLs) ranging from 2% to 97%.⁽⁵⁾ In 1908, Black identified WSLs for the first time.^(6,7) WSLs are described as demineralization of the enamel surface and subsurface without cavitation. These symptoms are the early clinical signs of dental caries development, with the possibility of reversal. These lesions are distinguished by their white, chalky, opaque appearance.⁽⁸⁾

At first, the mineral loss causes microporosities, which may be seen clinically as white, opaque, and rough areas. If the mineral loss persists, these WSLs will ultimately grow into lesions with cavitation.⁽⁹⁻¹¹⁾

WSLs are common in orthodontic patients, especially around bracket bases and in areas where brushing is difficult.^(12,13) Pathogenic bacteria enter the surface of the enamel and produce organic acids capable of dissolving the calcium and phosphate ions of the tooth structure, resulting in white spots.⁽⁸⁾ One of the most prevalent side effects of fixed orthodontic treatment is early enamel decalcification, which presents as WSLs. Initially, a WSL has an intact top layer, followed by the more porous lesion body, which gives the lesion a chalky opaque look since light is dispersed primarily within the lesion body.⁽¹⁴⁾ WSLs are frequently seen on the buccal surfaces of teeth, especially around brackets and in the gingival area.^(14,15)

The WSL pathogenesis may be various. The main cause is related to plaque accumulation over time; moreover, many other factors, such as diet and levels of calcium, phosphate, bicarbonate, fluoride in saliva, and genetic factors, are reported.⁽¹⁶⁾

The primary objective of this review is to comprehensively explore and evaluate the utilization of non-invasive methods for the treatment of WSLs in children. In doing so, we aim to highlight the significance of non-invasive approaches within pediatric dentistry and emphasize their potential benefits.

Non-invasive methods in pediatric dentistry have garnered increasing attention due to their capacity to address WSLs without resorting to surgical interventions. Such approaches include remineralization therapies, fluoride treatments, and minimally invasive restorative techniques.⁽¹⁶⁾ These methods aim to arrest the progression of WSLs and provide an opportunity for enamel remineralization, potentially reversing the damage and restoring the affected teeth to a healthy state.⁽¹⁷⁾

Resin infiltration (RI) therapy emerges as a prominent non-invasive option. This approach involves applying resin materials to demineralized enamel, effectively sealing and remineralizing the lesion without the need for drilling.^(8,14) Another promising non-invasive approach is casein phosphopeptide-amorphous calcium phosphate (CPP-ACP), a remineralization agent. It can be used alone or with fluoride treatments to enhance enamel demineralization. Studies by Ebrahim et al. explored alternatives to traditional fluoride treatments, such as MI Paste Plus, to promote remineralization and reduce the progression of WSLs.⁽¹⁸⁾ Minimal intervention dentistry (MID) principles emphasize conservative strategies that safeguard healthy tooth structure. Treatments like RI and CPP-ACP align with these principles.⁽¹⁹⁾

Although not a direct treatment, maintaining proper oral hygiene practices, including regular brushing and professional tooth cleaning, is crucial in managing WSLs and preventing their advancement.⁽¹⁷⁾

The significance of non-invasive methodologies in pediatric dentistry stems from their capacity to offer efficacious, streamlined, and less intrusive resolutions to a widespread dental issue among youngsters.⁽²⁰⁾ In contrast to invasive procedures that entail drilling and the substantial loss of tooth structure, non-invasive approaches prioritize the conservation of healthy tooth structure. This is particularly crucial when considering the dental health of youngsters, as their teeth are still growing and developing.

In addition, non-invasive techniques can provide a more pleasant and less anxiety-provoking encounter for pediatric patients,⁽²⁰⁾ which can positively influence their attitude toward dental care, decreasing fear and anxiety commonly associated with dental appointments and ultimately fostering improved adherence to preventative and therapeutic interventions.

Furthermore, non-invasive methodologies tend to be more cost-effective, benefiting both patients and healthcare systems.⁽¹⁹⁾ Using conventional invasive treatment modalities, such as drilling and filling, presents several inherent difficulties. Frequently, these treatments require extracting sound dental tissue, resulting in potential tooth fragility and jeopardizing the tooth's sustained functionality.⁽²⁰⁾

In light of the constraints associated with invasive interventions, there is an increasing demand for conservative options to manage WSLs successfully. Preserving good tooth structure is a primary concern in conservative treatments, as they aim to minimize the potential for iatrogenic harm and enhance patient experience.

Methods

The foundation of this study rested upon extensive electronic literature and secondary research conducted through renowned academic databases, including PubMed, MEDLINE, and Scopus. The study aimed to identify scholarly publications, clinical studies, case reports, original papers and review articles, predominantly in the English language, that pertained to the multifaceted domain of WSLs in pediatric dentistry. The choice of these databases was guided by their established reputation for housing an extensive repository of peer-reviewed articles, ensuring access to a comprehensive and relevant body of literature. We meticulously extracted data from the selected articles, from which relevant information regarding the study design, patient demographics, treatment methodologies, and outcomes was compiled. A structured framework facilitated the systematic organization of data, thus ensuring the synthesis of comprehensive and coherent insights.

Results and Discussion

We have summarized key findings from 25 scholarly articles focusing on WSL treatment in children (Table 1).

Table 1.

Summarized studies in a tabular format.

Authors	Type of Study	Number of Participants/ Objects	Treatment	Evaluation/ Diagnostic methods	Conclusion
Asokan et al. [21]	SR	Searched seven electronic databases, retrieved 158 clinical trials, assessed full text, included nine trials on CPP/ ACP	CPP-ACP	Visual scoring (ICDASII)	High-quality randomized controlled trials with low bias risk are required. CPP ACP showed a significant reduction in WSL size. Lack of evidence supporting other non-fluoridated agents.
Kannan & Padmanabhan [30]	RCT	12 patients with 240 WSLs in 193 teeth	Icon® RI and Clinpro™ XT varnish	Spectrophotometer for color assessment, DIAGNOdent® for fluorescence loss assessment	Immediately after the intervention, Icon® resin infiltration showed better color improvement. At 3 and 6 months, Clinpro™ XT varnish was more effective. Fluorescence loss improved with both interventions between immediate application and 6 months. At 6 months, Icon® resin-infiltrated WSLs were comparable to adjacent sound enamel, while Clinpro™ XT varnish-treated WSLs showed a significant difference.
Dhamija et al. [24]	RCT	60 patients	RI (Group 1) and Fluoride CPP-ACP varnish (Group 2)	ICDAS II scoring system, clinical examination	Resin infiltration was more successful than Fluoride CPP-ACP varnish in active non-cavitated WSLs.
Ebrahimi et al. [29]	RCT	80 patients	MI Paste Plus, Remin Pro, 2% Sodium Fluoride Gel, Usual Home Care (Control)	Intraoral photography, VistaCam iX for mineral content	MI Paste Plus and Remin Pro were as effective as 2% Sodium Fluoride in reducing WSLs in children. MI Paste Plus and Remin Pro are recommended as alternatives for managing WSLs.
Bourouni et al. [25]	SR/MA	11 studies, 1834 teeth in 413	RI	Visual-tactile, DIAGNOdent measurements	Resin infiltration has a significantly higher masking effect than natural remineralization or regular application of fluoride varnishes. However, this conclusion is based on only very few well-conducted RCTs. Resin infiltration seems a viable option to mask enamel white spot lesions and fluorosis esthetically.
Lopes et al. [32]	SR	143 references potentially relevant, with 99 publications from PubMed/Medline database, 33 from Scopus, and 11 from manual search.	SAPP11, CPP-ACP, HCL RI and fluoride-based products and chlorhexidine.	Visual examination or fluorescence, clinical photographs, cross-sectional microradiography, computed microtomography, DIAGNOdent.	There are no differences in the therapeutic approach for the treatment of white spot lesions, regardless of the type of diagnosis used.
Alexandru et al. [40]	R	N/A	RI technique (Icon by DMG) of the White Spot Lesion (WSL)	DIAGNOcam system, clinical evaluation, visual examination	An efficient and noninvasive diagnostic and monitoring method of the WSLs associated with infiltration therapy seems to be the ideal combination that follows the MID principles.
Güçlü et al. [33]	CIS	21 children with 101 WSLs	Four treatment groups: FV, CPP-ACP, CPP-ACP-FV, Control	Visual appraisals and laser fluorescence (LF) measurements.	Self-applications of CPP-ACP paste significantly improved the appearance and remineralization of WSLs. No advantage was observed for the use of fluoride varnish as a supplement to either the standard or CPP-ACP-enhanced oral hygiene regimes.
Bergstrand & Twetman [29]	R	25 publications that fulfilled human clinical trial criteria	Topical fluorides, fluoride toothpaste, professional applications of FV, remineralizing cream sugar alcohols, probiotics	Literature review, clinical trials with surrogate endpoints	The review highlights the importance of topical fluoride varnish and other interventions in preventing and treating WSLs during and after orthodontic treatment. Further research is needed to strengthen these findings.
Pintanon et al. [42]	IVtS	N/A	Caries infiltration (Icon), CPP-ACP containing paste (Tooth Mousse)	Vickers diamond indenter for surface hardness, spectrophotometer for color change, SEM for microscopic observation	Caries infiltration with resin material immediately improved surface hardness and esthetic appearance of artificial white spot lesions. CPP-ACP paste did not.

Table 1 (Continued).
Summarized studies in a tabular format.

Authors	Type of Study	Number of Participants/ Objects	Treatment	Evaluation/ Diagnostic methods	Conclusion
Ciftci et al. [34]	OA	68 patients (41 females and 27 males), 137 teeth	RI for developmental enamel opacities and WSLs, FV for WSLs	ICDAS II criteria, DIAGNOdent Pen scores	Resin infiltration was more successful than fluoride varnish for WSLs. Continuous fluoride application is needed for a similar effect. Resin infiltrate partially masked opaque lesions in developmental enamel opacities.
Simon et al. [22]	RCCT	60 children	RI (ICON, DMG, Germany) and Casein Phospho Peptide (CPP-ACP, Toothmousse, GC corporation, Germany)	Identification of WSLs with ICDAS I criteria, size measurement using clinical photographs, color assessment with a spectrophotometer, area calculation with Digimizer software	Both resin infiltration and CPP-ACP showed a significant reduction in lesion area and improved color of white spot lesions. They are recommended for managing post-orthodontic white spot lesions when the proper protocol is maintained.
Giray et al. [26]	RCT	23 children	RI vs. FV	Laser fluorescence device (DIAGNOdent pen, Kavo, Germany).	Resin infiltration and fluoride varnish are clinically feasible and efficacious methods for the treatment of anterior WSLs. The inhibition of caries progression by resin infiltration should now be considered an alternative to topical fluoride treatment.
Abbas et al. [14]	IVS	96 participants	RI with variations in etching and infiltrant applications	Spectrophotometric analysis of color change	Shallow enamel lesions were best treated with one etching and one infiltrant application. Deep enamel and shallow dentine lesions were best treated with one etching and two infiltrant applications. Deep dentine lesions required one etching with two infiltration steps but remained clinically detectable. As the WSLs got deeper, they became more clinically visible.
Alamoudi et al [35]	CR	Two patients	RI treatment for non-cavitated WSLs on anterior maxillary teeth	Patient interviews immediately after treatment and two weeks post-treatment, and examined with ICADS	Resin infiltration is a comfortable, conservative treatment option providing satisfactory outcomes in masking non-cavitated white spot lesions on anterior maxillary teeth after orthodontic treatment.
Ferreira et al. [36]	RCT	15 children	Two varnish formulations (G1 = 5% NaF, G2 = 6% NaF + 6% CaF ₂) for controlling white spot lesions	Dimensional measurements of WSL, Clinical features in a visual manner (texture and brightness), Activity classification	After 4 applications, both varnish formulations produced similar clinical effects, reducing and controlling carious activity in most WSL.
Eckstein et al. [37]	IVtS	9 subjects (49 trial teeth)	RI with Icon, DMG, Hamburg, Germany	CIE-Lab color assessment.	Resin infiltration effectively improved the appearance of post-orthodontic WSLs and maintained these cosmetic improvements over a 12-month period. The color and lightness characteristics of the Icon infiltrant remained stable, supporting its use for the long-term esthetic improvement of post-orthodontic WSLs.
Doméjean et al. [39]	SR	14 Studies used in the review but only 4 met the inclusion criteria	RI	Review of 4 in vivo studies	RI appears effective in arresting non-cavitated caries lesions. Additional long-term studies are needed.
Paris et al. [38]	IVvS	120 bovine enamel samples	Application of experimental infiltrants and commercial infiltrant (Icon, DMG)	Photographic images, color differences (ΔE) compared with untreated enamel	Resin infiltration can mask artificial enamel caries lesions, reducing color differences. Refractive indices of infiltrants may influence the aesthetic outcome and susceptibility to staining. Further research is needed.

Table 1(Continued).

Summarized studies in a tabular format.

Authors	Type of Study	Number of Participants/ Objects	Treatment	Evaluation/ Diagnostic methods	Conclusion
Memarpour et al. [23]	RCT	140 children	4 groups: 1. Control (no intervention) 2. Oral hygiene and dietary counseling 3. Oral hygiene and fluoride varnish application 4. Oral hygiene and tooth mousse (CPP-ACP) application	Size of WSL in millimeters and dmft index.	Oral hygiene, along with four fluoride varnish applications or constant CPP-ACP during the 12-month period, reduced the size of WSL in the anterior primary teeth and caused a small increase in the dmft index values.
Baafif et al. [41]	CS	30 participants	Split-mouth technique used, treating WSLs on the left side with ICON and on the right side with CPP-ACFP	Clinical evaluation using DIAGNOdent.	Both ICON and CPP-ACFP were effective in treating WSLs of smooth surfaces, but the efficacy of CPP-ACFP was better than ICON.
Elrashid et al. [43]	SR&MA	From 106 studies identified, 17 assessed	RI of proximal carious lesions	Risk of bias assessment, meta-analyses using RevMan software	The available evidence conveys high confidence that proximal resin infiltration has superior efficacy in slowing/arresting the carious lesions' progression rate in comparison to conventional management modalities.
Mendes et al. [27]	RCT	36 individuals	CPP-ACP	Monitoring with DIAGNOdent Pen	The use of CPP-ACP is a good alternative for the remineralization of white-spot lesions. The effect can be improved when this product is applied in combination with fluoride.
Gözetici, et al [31]	CS	134 participants	RI, P11-4, FV, Control	LAA-ICDAS scores, LF Pen measurements	Lesion regression was observed in all groups after six months, encouraging non-operative treatment approaches. Regular brushing and professional tooth cleaning are effective. Resin infiltration or fluoride varnish may enhance lesion improvement in moderate- to high-carries-risk individuals.

SR - Systematic Review, **RCT** - Randomized Clinical Trial, **SR/MA** - Systematic Review/Meta-analysis, **CIS** - Clinical Study, **R** - Review, **IViS** - In Vitro Study, **OA** - Original Article, **RCCT** - Randomized Control Clinical Trial, **CR** - Case Report, **IVvS** - In Vivo Study, **SR&MA** - Systematic Review & Meta-Analysis, **CS** - Comparative Study, **Icon®** - A brand or product name for resin infiltration, **Clinpro™ XT** - A brand or product name for varnish, **MI Paste Plus** - A product name, **SAPP11** - Self-Assembling Peptide, **HCL** - Hydrochloric Acid, **FV** - Fluoride Varnish, **GC Corporation** - A company or brand name, **DMG** - A company or brand name, **NaF** - Sodium Fluoride, **CaF2** - Calcium Fluoride, **P11-4** - A specific peptide or compound, **LF** - laser fluorescence, **DIAGNOdent** - scans a clean tooth surface with a laser beam, **ICDAS-LAA** - International Caries Detection and Assessment System—Lesion Activity Assessment;

These studies are presented in a tabular format, simplifying the presentation and allowing direct comparisons between them. The analysis of these studies reveals a rich landscape of research into diverse treatment modalities, diagnostic methods, and patient populations. RI stands out as an effective and minimally invasive treatment option, while CPP-ACP shows promise as a remineralization agent. Comparative studies provide valuable insights, and long-term effects and age-specific considerations are essential for treatment planning. As the research on WSL treatment advances, it is clear that personalized, conservative approaches are gaining prominence. The call for further research underscores the dynamic nature of the field, and ongoing studies will likely refine and expand our understanding of WSL management. Ultimately, the goal is to provide effective, evidence-based

treatments that improve oral health outcomes and the quality of life for individuals, especially children, affected by WSLs.

One striking feature of the analyzed studies is the diversity in study types, ranging from systematic reviews and randomized controlled trials to clinical studies, in vitro experiments, and case reports. This diversity reflects the multifaceted nature of WSLs and underscores the importance of investigating them through various research lenses.

Numerous authors exploring the intricacies of WSL management share striking similarities in their research approaches. This convergence of methodologies and findings underscores the significance of their collective contributions to this field of study.

Some common conclusions were found regarding CPP-ACP for WSL size reduction. Asokan et al. conducted

a systematic review emphasizing the significant reduction in WSL size with CPP-ACP treatment.⁽²¹⁾ This theme resonates across multiple studies, including Simon et al.⁽²²⁾ and Memarpour et al.⁽²³⁾ endorsing CPP-ACP efficacy in addressing these lesions. As for the efficacy of RI, its effectiveness in managing WSLs is a consistent finding across various studies. Dhamija et al.,⁽²⁴⁾ Bourouni et al.,⁽²⁵⁾ and Giray et al.⁽²⁶⁾ affirm the superiority of RI over other treatments, such as fluoride CPP-ACP varnish or fluoride varnish. RI for post-orthodontic WSLs was a topic discussed by Simon et al. and Giray et al., which specifically highlighted the effectiveness of RI in managing post-orthodontic WSLs, recommending its use when proper protocols are maintained.^(22,26)

As for the fluoride alternatives, studies such as Memarpour et al.,⁽²³⁾ Mendes et al.,⁽²⁷⁾ and Ebrahimi et al.⁽²⁸⁾ underscore the viability of alternatives to fluoride, such as MI Paste Plus or CPP-ACP, for managing WSLs.

According to a study conducted by Bergstrand and Twetman,⁽²⁹⁾ the literature they reviewed underscores the significance of utilizing topical fluoride varnish and other interventions in preventing and treating WSLs during and after orthodontic treatment. However, the study also highlights the need for further research to confirm and strengthen these findings.

The authors concluded that the use of remineralizing agents can be beneficial in the management of WSLs in children.^(23,28,29)

Throughout the literature, we also witnessed contrasting conclusions. The idea that color would be improved over time was discussed by Kannan and Padmanabhan, who found that Icon® RI showed immediate color improvement, while Clinpro™ XT varnish was more effective at 3 and 6 months.⁽³⁰⁾ Conversely, Dhamija et al.⁽²⁴⁾ favored RI over fluoride CPP-ACP varnish, indicating differing outcomes in terms of color improvement over time.

We also found a debate about RI vs. fluoride varnish where Gözetici et al.⁽³¹⁾ compared RI to fluoride varnish and observed lesion regression in all groups after six months. In contrast, Giray et al. supported RI as a viable alternative to fluoride varnish but noted that continuous fluoride application might be necessary for similar effects.⁽²⁶⁾

The studies employed various diagnostic methods, including visual scoring (ICDASII), spectrophotometry, fluorescence assessments (DIAGNOdent), and more. Authors such as Kannan & Padmanabhan,⁽³⁰⁾ Soveral et al.,⁽⁶⁾ and Lopes et al.⁽³²⁾ employed advanced diagnostic tools, like spectrophotometers and DIAGNOdent, to assess color and mineral content. On the other hand, studies like Güçlü et al.⁽³³⁾ and Memarpour et al.⁽²³⁾ incorporated visual appraisals and laser fluorescence measurements. These varying diagnostic methods underline the diversity of approaches in assessing WSLs.

There were also similarities in diagnosis, treatment, and conclusions. Simon et al.⁽²²⁾ and Giray et al.⁽²⁶⁾ explored RI as a treatment option. They also shared similarities in diagnostic methods, using visual scoring and spectrophotometry. While not identical, their conclusions highlighted the efficacy of RI in managing WSLs.

These studies collectively contribute to our understanding of WSL management, with recurring themes such as the efficacy of CPP-ACP and RI. However, differences in treatment outcomes and diagnostic approaches remind us of the complexity of these lesions and the need for ongoing research to refine treatment protocols further.

While some studies found certain treatments more effective than others, there is a consensus that non-invasive approaches can successfully manage WSLs, especially when combined with proper oral hygiene practices. Among the numerous treatment modalities explored, RI emerges as a prominent and effective option.^(14-16,22,24-26,34-37) RI therapy showed significant promise in reducing the size of WSLs and enhancing esthetic outcomes.^(38,39) The studies uniformly recommend it as a viable alternative to traditional fluoride treatments.^(14-16,22,24-26,34-37) Its minimally invasive nature aligns with the MID principles, emphasizing conservative approaches that preserve tooth structure.

The studies show that the most commonly used treatment methods for WSLs are RI and fluoride-based treatments, particularly fluoride varnish and CPP-ACP.^(14-16,22,24-26,34-37) These methods are frequently mentioned and evaluated across multiple studies. RI, in particular, stands out as a prominent treatment option.

As for the methods of diagnosis and evaluation, visual examination and scoring systems, such as the ICDASII, are commonly used. Additionally, some studies incorporate diagnostic tools like DIAGNOdent to assess fluorescence loss and spectrophotometers to assess color.^(24,34) The choice of diagnostic methods varies across the studies, including visual scoring based on ICDASII criteria, spectrophotometry, DIAGNOdent assessments, clinical examinations, and more. This variance in diagnostic tools underscores the need for a personalized approach to WSL management, allowing clinicians to tailor their interventions based on specific patient needs and lesion characteristics.⁽⁴⁰⁾

RI and CPP-ACP are two standout treatments in the quest to manage WSLs effectively.^(23,41) RI demonstrated significant success in both arresting lesion progression and improving esthetics. Multiple studies advocate for its clinical feasibility and consider it a valuable alternative to topical fluoride treatment.^(14-16,22,24-26,34-37) On the other hand, CPP-ACP, a non-invasive remineralization agent, displayed potential when used alone or in combination with fluoride.^(22,28,32,42) Its capacity to enhance remineralization is encouraging, particularly for managing non-cavitated WSLs.

Comparative studies play a crucial role in assessing the relative efficacy of different treatment options. These studies provide valuable insights into which interventions are more effective in specific scenarios. For instance, the comparison between RI and fluoride varnish indicated that both are clinically feasible and productive methods, though RI offers a notable alternative to traditional fluoride approaches.^(14-16,22,24-26,34-37) Several studies explored the long-term effects of treatments, highlighting the significance of follow-up and monitoring. RI, for instance, maintained cosmetic improvements over an extended period. Moreover, the age of the patient population was a variable in these studies, emphasizing the need for age-

specific treatment strategies and highlighting the challenges and opportunities presented by different age groups.

Conclusion

In conclusion, the extensive analysis of 25 studies on WSL treatment in children reveals a diverse landscape of research, showcasing the effectiveness of RI and the potential of CPP-ACP as prominent treatment modalities. Comparative studies provide valuable insights, emphasizing the importance of long-term effects and age-specific considerations in treatment planning. The diversity in study types and diagnostic methods highlights the need for personalized approaches to WSL management. While common conclusions emerge, such as the efficacy of CPP-ACP and RI, contrasting findings underscore the complexity of WSL management. A recurring theme in these studies is the call for additional research, especially long-term studies, to strengthen the evidence base for WSL treatment options. This indicates that the field is continually evolving, and there is room for further refinement of treatment protocols. Furthermore, many studies underscore the importance of conservative approaches to WSL management, emphasizing regular brushing, professional tooth cleaning, and minimally invasive interventions as key components of a holistic treatment strategy.

Competing Interests

The authors declare that they have no competing interests.

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