



Therapeutic Alternatives for Managing Hypersensitivity in Teeth Affected by Molar Incisor Hypomineralization in Children: a Scoping Review

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Abstract

Molar incisor hypomineralization (MIH) is a prevalent dental condition in children, affecting approximately 13–14% of the pediatric population worldwide. Dental care for MIH poses significant challenges due to the abnormal morphology and structure of enamel prisms, resulting in increased porosity and fragility, which make the teeth highly susceptible to hypersensitivity. Managing dentin hypersensitivity (DH) in children with MIH is particularly difficult. This article reviews current evidence on various treatments for hypersensitivity in children with MIH-affected teeth to identify the most effective and long-lasting options. This scoping review adhered to the criteria established by the PRISMA-ScR and conducted a thorough literature search from 2019 to 2024 using the PubMed, Scopus, and ScienceDirect databases. The search utilized the Concept, Population, and Context framework along with specific keywords to identify therapies for hypersensitivity in children's teeth affected by MIH. Nine studies from Brazil, Italy, Austria, Germany, and China were included, involving children aged 6 to 16 years, with sample sizes ranging from 42 to 214 teeth. The studies examined the efficacy and long-term durability of different methods and materials while evaluating a variety of management and treatment options for hypersensitivity in teeth affected by MIH. Treatments such as preemptive analgesia, sealants, laser therapy, and biomimetic hydroxyapatite paste effectively reduce hypersensitivity and improve quality of life related to oral health in children with MIH. The combination of laser therapy with desensitizers offers the most effective and sustained relief for hypersensitivity in MIH-affected teeth.

Keywords *Molar Incisor Hypomineralization, Tooth Hypersensitivity, Therapy Effectiveness, Young Permanent Teeth, Children*

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INTRODUCTION

Molar incisor hypomineralization (MIH) is a common tooth developmental problem in childhood, affecting approximately 13% to 14% of children worldwide (Rodd et al., 2021). The term MIH was first introduced in 2001 at the European Academy of Paediatric Dentistry (EAPD) workshop by Karin Weerheijm. The four first permanent molars (FPMs) may be affected by this condition to varying degrees, and in some cases, the incisors may also be affected (Hajdarević et al., 2024; Georgina-Pérez et al., 2023; Weerheijm et al., 2001).

This developmental defect leading to increased sensitivity, a higher risk of cavities, and aesthetic issues. The origins of MIH are complex, involving both genetic and environmental influences. Several genes linked to MIH have been reported recently, including MMP20, AMBN, and DEFB1,

which may influence MIH in the permanent dentition of children by affecting enamel production. A family association study conducted on a population of Brazilian families demonstrated that variations in genes related to amelogenesis, such as the AMBN gene (rs34367704), FAM83H gene (rs7821494), BMP2 gene (rs3789334), BMP4 gene (rs762642), BMP7 gene (rs6099486), ENAM gene (rs7664896), DLX3 gene (rs2278163), MMP20 gene (rs1711399, rs1711423), and AMELX gene (rs5979395), as well as FGFR1 gene (rs6996321), are linked to an increased risk of developing MIH (Pang et al., 2020).

Environmental factors influencing molar-incisor hypomineralization (MIH) can be categorized into perinatal, prenatal, and postnatal periods. Pregnant women who have health problems have a 40% increased risk of MIH compared to those without such issues. During the prenatal period, factors that may impact the development of ameloblasts include maternal viral infections, high fever, hypertension, diabetes, and medication use during pregnancy. The perinatal period involves complications such as premature birth, cesarean delivery, or low birth weight, all of which can reduce oxygen supply during amelogenesis and potentially contribute to MIH. High exposure to environmental influences during the postnatal period plays a crucial role in the manifestation of MIH. This exposure includes environmental pollution by dioxins, the child's medical history, and the use of prescribed medications (Ilczuk-Rypuła et al., 2022).

The assessment standards established by the European Academy of Paediatric Dentistry (EAPD) have remained mostly the same since 2003. As of 2010, these criteria include identifying at least one affected first permanent molar (with or without incisor involvement), detecting defined spots of opacity in the enamel, observing potential post-eruptive fractures in the damaged enamel and identifying increased clinical sensitivity in the tooth affected. These criteria increase the complexity of treatment since EAPD suggests premature extraction of teeth damaged by MIH in some circumstances as part of the diagnostic evaluation, as well as the use of non-traditional restorations for these teeth (Georgina-Pérez et al., 2023).

Clinically, MIH is defined by discernible alterations in tooth enamel translucency, with opacities greater than one millimeter. These opacities, which range in color from creamy white to yellow or brown, are often located on the smooth buccal or lingual surfaces of the incisors or first permanent molars. These unique alterations offer particular visual markers for identifying MIH (Georgina-Pérez et al., 2023).

In 2016, the Würzburg concept was developed for use in countries where German is the primary language. It includes the MIH Treatment Need Index (MIH-TNI), a classification index and a corresponding treatment plan. Based on the extent of damage and the presence of hypersensitivity, the MIH-TNI divides MIH into four groups. As understanding of MIH has evolved, non-invasive strategies were incorporated into version 2.0 of the concept, along with temporary treatment options and approaches for managing affected incisors (Bekes et al., 2023).

Dental care for MIH is challenging due to anomalies in the morphology and structure of the enamel prisms. These people are extremely vulnerable to cavities and tooth hypersensitivity due to the high porosity and fragility associated with this disorder. Patients with MIH often exhibit dentin hypersensitivity (DH), characterized by brief, sharp, and intense pain in response to external stimuli such as thermal, chemical, mechanical, or osmotic factors. This pain occurs due to exposed dentin and is not attributed to any other dental defect or illness. DH-related discomfort can interfere with eating and oral hygiene, even when local anesthesia is used during dental procedures. This discomfort may affect children's behavior and mental health.

Although exposed dentinal tubules are linked to DH, the precise reason is yet unknown. The most commonly accepted explanation for the pain and discomfort linked to DH is Brännström's hydrodynamic theory. The theory suggests that DH results from the rapid flow of fluid through the

dentinal tubules. This fluid moves in and out of the tubules in response to stimulation of the dentin, activating pulp baroreceptors that subsequently transmit pain signals to the central nervous system. The primary purpose of DH treatment is to lessen pain and enhance quality of life, either by desensitizing the sensory nerves to prevent pain signals from getting transmitted or by blocking the dentinal tubules (Juárez-López et al., 2023; Zhao et al., 2023; Bardellini et al., 2024).

There are several treatment options available, including the use of casein phosphopeptide-amorphous calcium phosphate (CPP-ACP) or casein phosphopeptide-amorphous calcium phosphate fluoride (CPP-ACPF)-containing toothpaste and oral care products. Other options include devices such as laser therapy. Managing dentin hypersensitivity (DH) in children with MIH is quite challenging due to the lack of a standardized, effective, and minimally invasive treatment for hypersensitivity in children with MIH (Bardellini et al., 2024; Diago et al., 2021).

The purpose of this article is to gather and evaluate the available data on different approaches to treating hypersensitivity in children's teeth affected by MIH, identifying those that offer the most effective and long-lasting relief for hypersensitivity in MIH-affected teeth.

METHOD

The PRISMA-ScR tool was utilized to conduct the scoping review research. Articles were searched and analyzed between June and August of 2024. The first step was to create a Population-Concept-Context (PCC) framework to aid in the search for relevant research materials. The inclusion criteria will take this PCC framework into consideration.

This search query focuses on studies related to "Molar Incisor Hypomineralization" (MIH) and its connection to hypersensitivity. In SCOPUS, the query uses the following combination: (TITLE-ABS-KEY ("Molar Incisor Hypomineralization" OR "MIH") AND TITLE-ABS-KEY ("hypersensitivity" OR "tooth sensitivity" OR "dentin hypersensitivity")) AND TITLE-ABS-KEY ("therapy" OR "treatment" OR "management" OR "intervention" OR "alternative therapy" OR "desensitizing agents" OR "fluoride application" OR "restorative materials" OR "sealant")) AND TITLE-ABS-KEY ("children" OR "pediatric" OR "young permanent teeth" OR "early permanent dentition"), with the publication year range restricted to 2018-2025 (AND PUBYEAR > 2018 AND PUBYEAR < 2025).

In ScienceDirect, the query is similar, searching for: ("Molar Incisor Hypomineralization" OR "MIH") AND ("hypersensitivity" OR "tooth sensitivity") AND ("treatment" OR "therapy") AND ("children" OR "pediatric"). For PubMed, the search is structured as: ("Molar Incisor Hypomineralization"[Title/Abstract] OR "MIH"[Title/Abstract]) AND ("hypersensitivity"[Title/Abstract] OR "tooth sensitivity"[Title/Abstract]) AND ("treatment"[Title/Abstract] OR "therapy"[Title/Abstract]) AND ("children"[Title/Abstract] OR "pediatric"[Title/Abstract]). All queries emphasize studies involving children, young permanent teeth, or early permanent dentition, focusing on treatment methods for MIH-related hypersensitivity.

Every database included will undergo a search utilizing all identified keywords and index phrases. PubMed, Scopus, and Science Direct are among the databases that will be used. The outlined inclusion and exclusion criteria focus on selecting observational and experimental studies, specifically excluding case reports, case series, research protocols, and review studies. Only scientific papers published in journals from 2019 to 2024, in English, and covering both foundational and supplementary research, including post-hoc analyses, are eligible. The target population is children with molar-incisor hypomineralization (MIH), excluding those with metabolic or genetic co-morbidities. The research focuses on available treatments for managing hypersensitivity in MIH-affected teeth, without restrictions on tooth type.

The goal of this scoping review is to ascertain the types of hypersensitivity treatments used for children's early permanent teeth that have MIH. Using predetermined keywords, three search engines were utilized in the study's initial phase to find relevant publications. In the first phase, a total of 97 papers were gathered: 48 from Scopus, 25 from PubMed, and 24 from Science Direct. After removing 24 articles, the remaining 73 items were subjected to duplicate removal. Following that, 24 articles remained after additional screening based on the title and abstract, while 49 articles were eliminated. After filtering the articles using full-text reviews, nine satisfied the inclusion criteria, while fifteen did not. The PRISMA-ScR diagram illustrates the process of selecting and screening these publication.

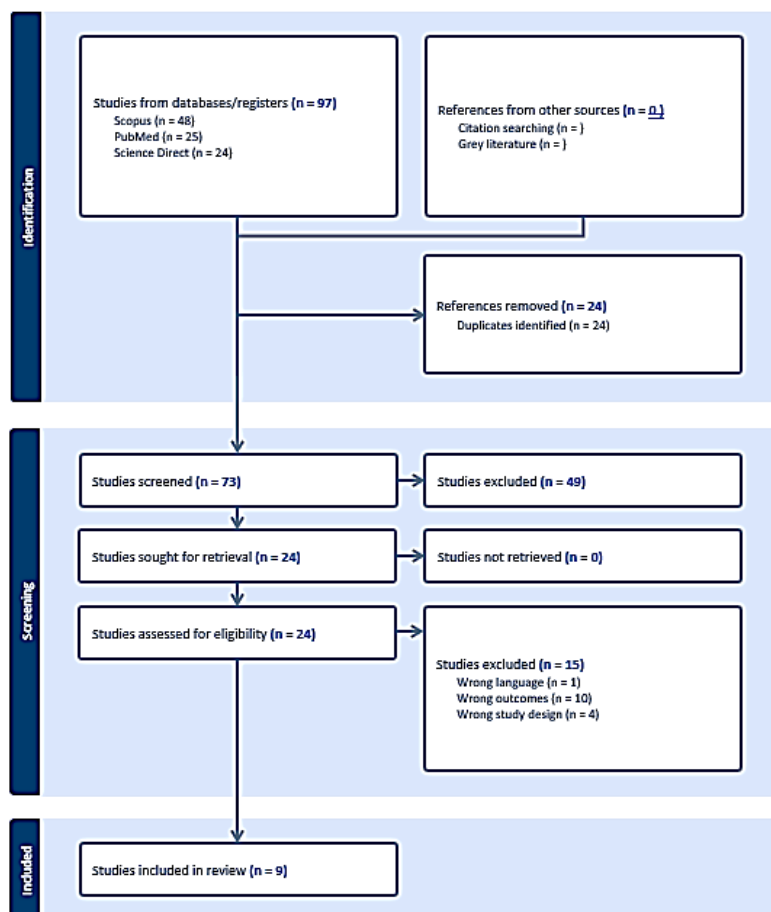


Figure 1. PRISMA-ScR Diagram

RESULTS AND DISCUSSION

The articles included in this scoping review fall within the 2019–2024 time frame, covering the last five years. Nine clinical trial studies were identified from the examined papers. A total of ten studies represent most of the research discussed in the article, with most carried out in Brazil. The remaining studies were conducted in other countries: three in Italy, two in Austria, two in Germany, one in China, and one in Germany.

According to the studies listed in Table 3, MIH ranks as one of the most challenging conditions to treat in pediatric dentistry because poses several clinical challenges, including dental hypersensitivity, difficulty achieving adequate analgesia or anesthesia, a higher risk of carious lesions, a high failure rate for restorations, elevated dental anxiety, and impaired aesthetics. The use of analgesic

medication before a clinical treatment to avoid or reduce postoperative and transient hypersensitivity is known as preemptive analgesia.

This approach is frequently utilized in endodontic therapy and third molar extraction. Vicioni-Marques et al. (2022) found that using ibuprofen as a preventative analgesic significantly improved anesthetic efficacy and reduced hypersensitivity during dental procedures in children with severe MIH. Children who received ibuprofen experienced less hypersensitivity compared to the placebo group, both before and after anesthesia, as well as during the dental procedure. However, there was no significant difference in hypersensitivity between the two groups two hours after the procedure. This highlights the benefits of using preemptive analgesia to enhance patient comfort and the effectiveness of anesthesia during restorative treatments in MIH-affected children.

Diago et al. (2021) contribute by proposing and evaluating a well-defined, minimally invasive treatment protocol using superficial resin infiltration. The study aimed to develop a standardized protocol using resin infiltration on 42 pediatric patients, all of whom experienced significant improvements in sensitivity, with results sustained over a 12-month follow-up period. The effectiveness of resin infiltration in managing hypersensitivity in children with MIH, as demonstrated in the study, is attributed to several key factors. First, the resin works by penetrating and sealing the porous enamel structure typical of MIH-affected teeth, thereby preventing the exposure of dentin tubules, which are a primary cause of hypersensitivity.

Additionally, the technique involves superficial erosion of the outer enamel layer using orthophosphoric acid, followed by infiltration with low-viscosity resin. This process allows the resin to penetrate the enamel defects and fill in gaps, strengthening the enamel and reducing sensitivity to external stimuli such as cold air or food. The procedure is also minimally invasive, preserving the natural tooth structure while providing significant improvements in sensitivity.

The study found that even a single application was effective, with the resin remaining stable within the enamel's porosity under normal chewing forces. Lastly, the resin infiltration provides a long-lasting effect, as the reduction in hypersensitivity was sustained throughout the 12-month follow-up period. Improving dental hypersensitivity could have a favorable impact on patients' quality of life. These combined factors make resin infiltration a promising treatment for MIH-related hypersensitivity, offering an effective solution without the need for more invasive dental procedures.

Due to their greater susceptibility to caries, people with molar-incisor hypomineralization (MIH) need more frequent and comprehensive dental care. It is crucial to put in place a thorough preventive strategy as soon as lesions are found in the first permanent teeth. Fissure sealants are advised as a preventive intervention in milder cases of MIH when the first permanent molars (FPM) are sensitive to stimuli like air or water but do not exhibit symptoms of post-eruptive breakdown (PEB) (Jayanti & Riyanti, 2024).

The first study assessing the use of two sealing procedures to alleviate hypersensitivity in molars affected by MIH was conducted in 2022 by Bekes et al. As soon as a tooth with MIH is identified, it is crucial to begin an intensified preventive regimen. Sealing MIH molars is regarded as a useful and effective preventive step in addition to previously described preventive techniques. Generally, the application of pit and fissure sealants is one of the most popular and widely recognized dental treatments for the prevention or management of caries on occlusal surfaces. Numerous clinical trials have demonstrated their effectiveness (Bekes et al., 2022).

The study concludes that both composite and glass ionomer sealants were effective in reducing hypersensitivity in molars affected by MIH immediately after treatment and throughout the 12-week follow-up period. There was no significant difference in performance between the two materials in terms of reducing hypersensitivity or retention rates. While both materials significantly decreased

hypersensitivity, partial loss of sealant was observed over time, especially with glass ionomer cement. These findings support the use of sealing techniques as a viable option for managing hypersensitivity in MIH-affected teeth (Bekes et al., 2022).

In 2021, Bekes et al. carried out a study to compare the quality of life linked to oral health (OHRQoL) before and after applying a sealant to hypersensitive molars impacted by MIH. Since clinical signs alone are unable to adequately convey the impact of oral health concerns on a patient's psychological well-being, the concept of OHRQoL is now essential for assessing the condition of oral health in both adults and children. The CPQ8–10 scores decreased significantly from a baseline mean of 14.7 to 6.4 one week after treatment and further to 2.7 after 12 weeks. The improvement was consistent across all subdomains of the CPQ8–10, including oral symptoms and functional limitations. These findings suggest that sealing hypersensitive MIH-affected molars can significantly enhance children's OHRQoL by effectively reducing hypersensitivity and maintaining these benefits over time (Bekes et al., 2021).

A laser is a concentrated beam of coherent, monochromatic light (or electromagnetic radiation) generated by specific equipment. Lasers have been used in various dental treatments, with their first application for managing dentinal hypersensitivity dating back to 1985. Combining lasers with chemical agents has also been recognized as an effective method for treating dentinal hypersensitivity. Some alternatives have been put forward. The novel and secure Erbium-doped Yttrium garnet (Er:YAG) laser is non-invasive, user-friendly, and safe. In recent times, laser therapy has proven to be a more effective long-term treatment for dental hypersensitivity (DH) than desensitizers because it immediately affects the tissue of the teeth, causing modifications in the dentin's morphology, activating the pulp tissue, and lengthening the duration of the treatment (Zhao et al., 2023; Mahdian et al., 2021).

To determine whether Er laser therapy and GLUMA desensitizer effectively reduce DH in children with MIH, Zhao et al. (2023) conducted a study. GLUMA desensitizer is a formulation that combines glutaraldehyde and 2-hydroxyethylmethacrylate (HEMA), which can coagulate serum albumin in dentinal fluid. This coagulation reaction causes HEMA polymerization, forming a coagulation plug that resembles the melted layer produced after laser irradiation. The study found that the combination of Er laser therapy and GLUMA desensitizer was more effective in reducing dentin hypersensitivity and improving OHRQoL in children with MIH. Specifically, the group treated with both Er laser and GLUMA desensitizer showed the greatest and longest-lasting reduction in dentin hypersensitivity over a 6-month period compared to other treatment groups. This combined therapy also resulted in significant improvements in functional limitations, physical pain, and psychological well-being.⁹

Bardellini et al. (2024) conducted a study to evaluate the effectiveness of three different desensitizing treatment protocols for managing DH in pediatric patients with MIH. The study specifically investigated the effects of CPP-ACPF mousse, photobiomodulation therapy (PBMT), and a combination of both treatments on reducing hypersensitivity in affected teeth. The findings indicated that both CPP-ACPF mousse and PBMT were effective in reducing DH in children with MIH; however, the combination of the two treatments proved to be the most effective.

Children in the group that received both therapies experienced significantly lower pain scores on the Visual Analogue Scale (VAS) compared to those who received only one of the treatments. The combined therapy led to a more immediate and longer-lasting reduction in hypersensitivity, with significant improvements noted after the first session and persisting over the 28-day follow-up period (Bardellini et al., 2024).

The combined effects of these two medications may increase the overall desensitization impact through their synergistic activities. The dentinal tubule occlusion provided by CPP-ACPF, along with

the regenerative qualities of PBMT, aids in the development of tertiary dentin, strengthening the body's pain defense system. Additionally, the immediate relief from PBMT complements the longer-lasting occlusive effects of CPP-ACPF, leading to a faster and more complete reduction in dentin hypersensitivity. This combined approach leverages the strengths of both therapies to provide better and longer-lasting relief from dental sensitivity related to MIH (Bardellini et al., 2024).

The study conducted by Muniz et al. (2020) evaluated the effectiveness of low-level laser therapy (LLLT) combined with fluoride varnish (FV) in reducing DH in children with MIH. Sensitivity was measured at different intervals, including before treatment, after 48 hours, and over a four-week follow-up period. The study concluded that while both LLLT and fluoride varnish effectively reduced hypersensitivity, the combined therapy provided the greatest overall relief, with a 93% reduction in sensitivity compared to 79% in the LLLT group and 87% in the fluoride varnish group. Follow-up data confirmed that the desensitizing effects were sustained over time, particularly in the group receiving both treatments. This indicates that combining the immediate pain relief of LLLT with the long-term effects of fluoride varnish offers the most comprehensive treatment for DH in children with MIH.

When used together, low-level laser therapy (LLLT) provides immediate pain relief by directly affecting the nerves, while fluoride varnish delivers a more gradual, long-term reduction in sensitivity by occluding the dentinal tubules. The combination of these two therapies works synergistically: LLLT addresses immediate pain, and fluoride varnish strengthens and protects the enamel over time, leading to a more comprehensive and sustained reduction in dentin hypersensitivity (DH) (Muniz et al., 2020).

Several studies have examined the connection between molar-incisor hypomineralization (MIH) and oral hygiene, revealing that the severity of the condition is associated with heightened sensitivity and poorer oral hygiene. Teeth affected by MIH tend to be more sensitive to cold stimuli and have rougher surfaces, increasing the likelihood of caries and making it harder to maintain good dental hygiene. Butera et al. (2023) stated that biomimetic zinc-hydroxyapatite paste had a significant desensitizing effect on teeth affected by MIH.

The paste was applied over a 9-month period, and results showed a reduction in both dental hypersensitivity and the MIH-TNI in the treated group compared to the control group, which did not receive the paste. Specifically, the Schiff Air Index (SAI) scores, which measure sensitivity, were significantly lower in the test group after 1 and 3 months, indicating the effectiveness of the paste in reducing sensitivity. The study concluded that the biomimetic paste is an effective at-home treatment option for managing dental sensitivity in children with MIH (Butera et al., 2023).

Biomimetic hydroxyapatite paste is effective in reducing dental sensitivity because it mimics the natural structure of tooth enamel. The nano-hydroxyapatite particles fill in tiny gaps and defects in the enamel, helping to rebuild and strengthen it. This also blocks the exposed dentinal tubules, which are responsible for sensitivity, by preventing stimuli like heat or cold from reaching the nerves. Additionally, the paste promotes remineralization, restoring minerals to the enamel and making it more resistant to wear and damage, providing both immediate relief and long-term protection.

The study conducted by Ehlers et al. (2021) demonstrated that both the microcrystalline hydroxyapatite toothpaste and the amine fluoride toothpaste were effective in lowering hypersensitivity in MIH after 8 weeks. However, the non-inferiority of the hydroxyapatite toothpaste in comparison to the amine fluoride toothpaste could not be definitively established. In the ITT population, the hydroxyapatite toothpaste was found to be non-inferior, with a mean reduction in pain sensation measured on the Visual Analog Scale (VAS). However, in the per-protocol (PP) population, non-inferiority could not be established due to the loss of statistical power caused by participant dropouts related to the COVID-19 pandemic. Overall, although children in the group given hydroxyapatite had

a tendency to show reduced hypersensitivity, these findings need to be confirmed by larger sample sizes and longer follow-up periods.

The scoping review offers several advantages. First, it conducted a comprehensive literature search using three major databases (Scopus, PubMed, and Science Direct), ensuring broad and inclusive coverage of available studies, which increased the likelihood of identifying diverse treatment options for managing hypersensitivity in MIH-affected teeth. Additionally, by focusing on studies published between 2019 and 2024, the review ensured that the most recent and relevant research was included, reflecting the latest advancements in the field. The review also benefited from a well-defined Population-Concept-Context (PCC) framework, which structured the search and selection process, enhancing the systematic nature of the review.

Furthermore, it concentrated on the pediatric population, specifically targeting children with MIH, making the findings particularly applicable to addressing hypersensitivity management in young patients. However, there are some disadvantages to the review. One limitation is the restriction to English-language studies, which may have excluded relevant research published in other languages, thereby limiting the review's scope. Additionally, some included studies featured limited follow-up periods, hindering the assessment of the long-term efficacy of specific treatments. Notwithstanding these limitations, the review provides a thorough evaluation of the current evidence while highlighting areas for future research.

CONCLUSION

Molar incisor hypomineralization (MIH) presents major challenges in pediatric dentistry, including hypersensitivity, heightened caries risk, and poor anesthesia response. Various treatments show promise: preemptive ibuprofen analgesia enhances anesthetic efficacy in severe MIH cases; resin infiltration sustains hypersensitivity reduction for 12 months; fissure sealants with composite or glass ionomer provide immediate and short-term (up to 12 weeks) relief while improving oral health-related quality of life (OHRQoL); at-home biomimetic zinc- or microcrystalline hydroxyapatite products offer effective sensitivity management, though long-term data are limited. Combination therapies excel, particularly Er laser with GLUMA desensitizer for superior immediate and sustained relief, outperforming options like CPP-ACPF mousse with photobiomodulation or low-level laser therapy (LLLT) with fluoride varnish in functional and psychological benefits. Future research should prioritize randomized controlled trials comparing long-term efficacy of hydroxyapatite-based at-home therapies against laser-desensitizer combinations in diverse pediatric populations to refine evidence-based guidelines.

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