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Review Article

Approaches to Remineralizing Teeth Affected by Molar-Incisor Hypomineralization (MIH): A Review of the Literature

Philipp Graf[1], Theresa Lorenz[1*], Johann Busch[1]

[1]Charité Center for Dental Medicine, Department of Orthodontics, Dentofacial Orthopedics and Pedodontics, Charité—Universitätsmedizin Berlin, Berlin, Germany

***E-mail** ✉ tlorenz88@gmail.com

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ABSTRACT

Molar incisor hypomineralization (MIH) is a widespread developmental dental condition that imposes significant clinical challenges and often requires extensive management, yet no exhaustive review has examined all non-invasive remineralization approaches for MIH. Affected teeth generally show decreased mineral content and hardness, which contribute to sensitivity and compromised function. Therefore, therapies utilizing calcium phosphate compounds are considered promising for restoring MIH-affected enamel. This review summarizes current research on various remineralizing agents studied for MIH, including casein phosphopeptide–amorphous calcium phosphate (CPP-ACP), casein phosphopeptide–amorphous calcium fluoride phosphate (CPP-ACFP), hydroxyapatite, calcium glycerophosphate, self-assembling peptides, and fluoride. Nineteen studies, encompassing in vitro, in situ, and in vivo investigations, were identified. An additional search focused on toothpaste-based interventions for MIH revealed six studies, three addressing remineralization and three targeting sensitivity alleviation. The findings indicate that MIH-affected teeth can benefit from calcium phosphate-based remineralization, with CPP-ACP, hydroxyapatite, and calcium glycerophosphate demonstrating notable effectiveness, while CPP-ACP and hydroxyapatite also help reduce tooth sensitivity associated with MIH.

Keywords: Toothpaste, CPP-ACP, Dentifrice, Calcium phosphate, Hydroxyapatite, Fluoride

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Introduction

Molar incisor hypomineralization (MIH) is a common developmental dental disorder that poses considerable health challenges for affected individuals [1]. Research indicates a global prevalence of approximately 14.2%, with regional variations ranging from around 11% to 18% [2]. MIH is characterized as a qualitative enamel defect of systemic origin, typically involving at least one of the first permanent molars and frequently accompanied by opacities on the permanent maxillary incisors, with less frequent involvement of the permanent mandibular incisors [3, 4]. A clinical illustration of MIH is shown in **Figure 1**.

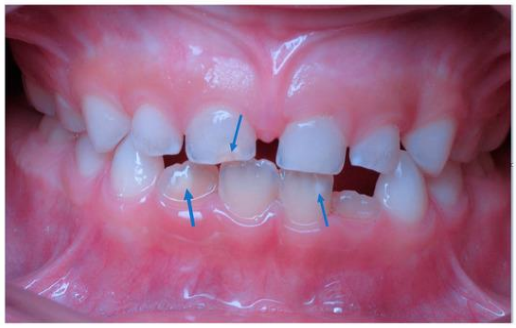

Figure 1. Clinical image of molar incisor hypomineralization (MIH) showing a mild presentation on primary tooth #E and permanent teeth #24 and #26 (American numbering system).

MIH is clinically diagnosed when opacities appear as well-defined changes in enamel translucency, measuring over 1 mm, with colors ranging from creamy white to yellow or brown, typically located on the smooth buccal or lingual surfaces of first permanent molars or incisors [4, 5]. Although the exact cause of MIH remains unclear, it is recognized as a multifactorial developmental enamel defect influenced by genetic and systemic factors, with perinatal and postnatal influences having stronger associations than prenatal factors [6]. A recent hypothesis suggests that serum albumin in the enamel matrix may interfere with mineralization during enamel maturation, a phenomenon termed "mineral poisoning" [7]. While MIH and dental fluorosis can be differentiated clinically, Fernandes *et al*. reported a possible positive correlation between MIH severity and dental fluorosis [8], which may occur in permanent molars and incisors when children are exposed to high fluoride levels from birth to six years [9].

Analytical studies have shown that MIH-affected enamel has lower mineral content, disrupted organization, widened prism sheaths, and reduced calcium but elevated carbon and protein levels compared to healthy enamel [10–15], resulting in a more porous surface with reduced hardness [10–14]. Consequently, MIH teeth are more prone to caries [7, 16, 17] and often present with tooth sensitivity [18–21]. These patients require specialized dental care and preventive oral hygiene strategies. Although guidelines suggest the routine use of topical remineralization agents like fluoride [5], evidence supporting the effectiveness of different treatment protocols in this population remains limited [22]. Remineralization strategies aim to enhance the mineral content of hypomineralized enamel, improving its mechanical properties and resistance to breakdown and caries [23], highlighting the need for novel agents and further research.

Calcium phosphate-based compounds, such as casein phosphopeptide–amorphous calcium phosphate (CPP-ACP; ACP: Cax(PO4)Y · n H2O) and hydroxyapatite (HAP; Ca5(PO4)3(OH)), have attracted attention as biomimetic agents for enamel and dentin remineralization, caries prevention [24–30], biofilm control [31, 32], periodontal health [33], and whitening [34]. Hydroxyapatite particles can form mineral-mineral bridges with natural enamel surfaces [35]. Given that MIH teeth exhibit reduced hydroxyapatite content and density [10], using calcium phosphate-based oral care formulations is a logical approach [25, 28]. Moreover, calcium phosphates, particularly hydroxyapatite, may help alleviate MIH-related tooth sensitivity [18, 20, 36]. Unlike fluoride, which carries a risk of dental fluorosis and other adverse effects [37–39], calcium phosphates are highly biocompatible and safe if ingested [40], with nanoparticulate amorphous calcium phosphate naturally present in human breast milk [40].

This narrative review aims to provide a current overview of studies evaluating the remineralization potential of various active agents for MIH-affected teeth, with the goal of informing daily oral care recommendations for this patient group.

Materials and Methods

Search strategy

The initial search focused on identifying studies related to MIH and remineralization. Searches were conducted using the terms (MIH OR "molar incisor hypomineralization" OR "molar incisor hypomineralisation") AND (remineralization OR remineralisation OR mineralization OR mineralisation) across PubMed, Google Scholar, and SciFinder. Articles were screened by title and abstract, excluding those not centered on remineralization as well as review papers. All active agents investigated for MIH remineralization were considered, and duplicate records appearing in multiple databases were counted only once.

A supplementary search aimed to capture studies exploring MIH in relation to toothpaste. Using PubMed, the search terms (MIH OR "molar incisor hypomineralization" OR "molar incisor hypomineralisation") AND (toothpaste OR dentifrice) were applied. After title and abstract screening, studies unrelated to toothpaste/dentifrice use and review articles were removed. In vitro, in situ, and in vivo studies were all included, considering publications up to 20 December 2022.

Results and Discussion

The results are divided into general remineralization studies and those specifically addressing toothpaste. Nineteen studies (covering in vitro, in situ, and in vivo designs) examined different remineralization approaches for MIH-affected teeth **(Table 1)**. Most research focused on calcium phosphate-based agents, including CPP-ACP (10 studies), CPP-ACFP (6 studies), hydroxyapatite (3 studies), and calcium glycerophosphate (2 studies), with one study evaluating a self-assembling peptide. Six studies tested fluoride-containing formulations independently of CPP-ACFP, typically in the form of fluoride varnishes.

Table 1. Summary of Studies (In Vitro, In Situ, In Vivo) Investigating MIH Remineralization Effects of Various Formulations and Active Ingredients. Note: For detailed experimental protocols of in situ studies related to MIH, refer to [25]. Studies are organized by type: in vitro, in situ, in vivo.

No.	Paper (Year of Publication)	Condition Assessed	Tested Products and Controls	Key Findings from Abstract
1	Evaluation of the efficacy of CPP-ACP remineralizing mousse in molar-incisor hypomineralized teeth using polarized Raman and scanning electron microscopy: An in vitro study (2022) [41]	Remineralization (Raman microscopy, scanning electron microscopy) / in vitro	CPP-ACP tooth mousse	Treatment with CPP-ACP tooth mousse enhanced mineral density and organization in hypomineralized enamel.
2	Evaluation of the efficacy of CPP-ACP remineralizing mousse in MIH teeth with white and yellow opacities-in vitro Vickers microhardness analysis (2022) [42]	Remineralization (Vickers microhardness) / in vitro	CPP-ACP mousse	CPP-ACP topical application increased physical strength in hypomineralized and transition enamel areas, likely due to higher mineral content.
3	In vitro polarized Raman analysis for the evaluation of the efficacy of CPP-ACP remineralizing mousse in tooth hypomineralization (2021) [43]	Remineralization (polarized Raman microscopy) / in vitro	Casein phosphopeptide amorphous calcium phosphate (CPP-ACP)	CPP-ACP tooth mousse improved mineral density and enamel organization in hypomineralized enamel.
4	Mineralisation of developmentally hypomineralised human enamel in vitro (2013) [23]	Remineralization (TMR, polarized light microscopy) / in vitro	Surface layer removal ± NaOCl pre-treatment, 14-day CPP-ACFP solution exposure	Treatment with CPP-ACFP solution increased mineral content (1828 ± 461 vol% min · μm, %R = 17.7 ± 5.7) and reduced porosity, proving remineralization potential in hypomineralized enamel post-eruption.
5	Remineralization of molar incisor hypomineralization (MIH) with a hydroxyapatite toothpaste: an in-situ study (2022) [25]	Remineralization (microcomputed tomography) / in situ	Hydroxyapatite toothpaste (20% hydroxyapatite), fluoride toothpaste (1450 ppm)	Hydroxyapatite toothpaste remineralized MIH lesions, with enhanced effects after acid-etchant pre-treatment.
6	An evaluation of remineralised MIH using CPP-ACP and fluoride varnish: An in-situ and in-vitro study (2022) [44]	Remineralization (energy-dispersive spectroscopy: Ca/P content) / in situ and in vitro	CPP-ACP-based cream, fluoride varnish	Remineralization of MIH-affected teeth was achieved using remineralizing agents.
7	Biomimetic hydroxyapatite paste for molar-incisor hypomineralization: A randomized clinical trial (2022) [45]	Parameters: Plaque Control Record (PCR), Bleeding Index (BI), MIH Treatment Need Index (MIH-TNI), Schiff Air Index (SAI) / in vivo	Zinc-hydroxyapatite-based paste	Zinc-hydroxyapatite paste demonstrated a desensitizing effect in MIH treatment.
8	Effect of remineralization agents on molar-incisor hypomineralization-affected incisors: A randomized controlled clinical trial (2022) [46]	Remineralization (laser fluorescence) / in vivo	Calcium glycerophosphate (CaGP), CPP-ACFP, control (1450 ppm fluoride toothpaste)	Both CaGP and CPP-ACFP improved MIH lesions through mineral deposition; further long-term studies recommended.

9	Effect of casein phosphopeptide amorphous calcium fluoride phosphate and calcium glycerophosphate on incisors with molar-incisor hypomineralization: A cross-over, randomized clinical trial (2022) [47]	Remineralization (laser fluorescence) / in vivo	CPP-ACFP, calcium glycerophosphate (CaGP)	CPP-ACFP and CaGP reduced hypomineralization in MIH-affected enamel over three months.
10	Effects of different remineralization agents on MIH defects: a randomized clinical study (2022) [48]	Remineralization (ICDAS, laser fluorescence) / in vivo	Control (oral hygiene only), fluoride varnish, CPP-ACP paste, CPP-ACFP paste	Calcium- and phosphate-containing pastes were recommended for long-term preservation of yellow-brown MIH defects prone to post-eruptive breakdown.
11	A comparative evaluation of CPP-ACP cream and fluoride varnish in remineralization of MIH-affected teeth using laser fluorescence (2021) [49]	Remineralization (laser fluorescence) / in vivo	Fluoride varnish (professional), CPP-ACP cream (daily)	Both fluoride varnish and CPP-ACP cream were equally effective in remineralizing MIH-affected teeth.
12	Assessment of remineralization of hypomineralized enamel lesions using self-assembling peptide using laser fluorescence - a pilot study (2021) [50]	Remineralization (laser fluorescence) / in vivo	Self-assembling peptide (SAP)	SAP application was a viable treatment option for remineralizing hypomineralized enamel.
13	Management of a hypomineralisation of the enamel by applying a remineraliser based on zinc hydroxyapatite (microRepair) (2021) [51]	Remineralization (photographic evaluation) / in vivo	Biomimetic nanohydroxyapatite mousse	One year post-diagnosis, treated teeth showed no MIH symptoms.
14	In vivo comparative evaluation of esthetics after microabrasion and microabrasion followed by casein phosphopeptide-amorphous calcium fluoride phosphate on molar incisor hypomineralization-affected incisors (2019) [52]	Tooth color (photographic evaluation) / in vivo	Microabrasion, microabrasion + CPP-ACFP	Microabrasion followed by CPP-ACFP improved aesthetics of white tooth discoloration over time.
15	The effect of casein phosphopeptide-amorphous calcium phosphate on molar-incisor hypomineralisation: A pilot study (2017) [53]	Remineralization (laser fluorescence) / in vivo	10% CPP-ACP paste, 10% CPP-ACFP (with 0.2% NaF)	Both CPP-ACP and CPP-ACFP reduced hypomineralization in MIH-diagnosed teeth over one month; early diagnosis and further studies needed.
16	Comparison of mineral density in molar incisor hypomineralization applying fluoride varnishes and casein phosphopeptide-amorphous calcium phosphate (2017) [54]	Remineralization (laser fluorescence) / in vivo	5% sodium fluoride varnish (Duraphat®), 5% sodium fluoride varnish with tricalcium phosphate (Clinpro®), CPP-ACP (Recaldent®)	Clinpro® was more effective for mild lesions, Duraphat® for moderate lesions.
17	Effect of fluoride varnish on enamel remineralization in anterior teeth with molar	Remineralization (quantitative light-	Four 5% NaF varnish applications (1-week	No beneficial remineralization effect observed in MIH lesions

	incisor hypomineralization (2016) [55]	induced fluorescence) / in vivo	intervals), usual home care (control)	after fluoride varnish applications.
18	An innovative approach to treat incisors hypomineralization (MIH): A combined use of casein phosphopeptide-amorphous calcium phosphate and hydrogen peroxide - a case report (2012) [56]	Aesthetic appearance (photographic evaluation) / in vivo	CPP-ACP mousse + hydrogen peroxide gel	Noticeable aesthetic improvement of opacities after five months of treatment.
19	MIH supplementation strategies: prospective clinical and laboratory trial (2011) [28]	Mineralization, morphology, porosity (SEM, ESEM/EDX) / in vivo	Calcium-phosphate casein	Calcium-phosphate casein improved enamel morphology in vivo, rejecting the null hypothesis.

A further search for research examining the use of toothpaste in the context of MIH identified six studies, with three addressing remineralization and the other three focusing on sensitivity reduction **(Table 2)**. CPP-ACFP, typically in the form of fluoride varnishes.

Table 2. Summary of Studies (In Situ and In Vivo) on Toothpaste Use in Molar Incisor Hypomineralization (MIH) Note: The search was not restricted to remineralization studies. For experimental details on in situ studies related to MIH, refer to [25].

Study No.	Paper (Year)	Condition Evaluated	Products Tested and Controls	Key Findings from Abstract
1	Remineralization of molar incisor hypomineralization (MIH) with a hydroxyapatite toothpaste: an in-situ study (2022) [25]	Remineralization (assessed via microcomputed tomography, in situ)	Hydroxyapatite toothpaste (20% hydroxyapatite), Fluoride toothpaste (1450 ppm fluoride)	Hydroxyapatite-based toothpaste effectively remineralized MIH lesions. Acid-etchant pretreatment enhanced remineralization.
2	Effect of remineralization agents on molar-incisor hypomineralization-affected incisors: A randomized controlled clinical trial (2022) [46]	Remineralization (assessed via laser fluorescence, in vivo)	Calcium glycerophosphate (CaGP), Casein phosphopeptide amorphous calcium fluoride phosphate (CPP-ACFP), Control (1450 ppm fluoride toothpaste)	Both mineral-containing agents improved MIH lesions through mineral deposition. Further studies are needed to evaluate long-term effects and larger sample sizes.
3	Efficacy of a toothpaste based on microcrystalline hydroxyapatite on children with hypersensitivity caused by MIH: A randomised controlled trial (2021) [18]	Hypersensitivity (pain response to tactile stimuli, assessed via Wong-Baker FACES Pain Rating Scale, in vivo)	Hydroxyapatite toothpaste (10% HAP), Fluoride toothpaste (1400 ppm amine fluoride)	Hydroxyapatite toothpaste showed a trend toward reduced hypersensitivity but did not demonstrate non-inferiority compared to amine fluoride. Study power was reduced due to COVID-19-related attrition.
4	Molar incisor hypomineralization treatment with casein phosphopeptide and amorphous calcium phosphate in children (2018) [20]	Hypersensitivity (to mechanical and thermal stimuli, in vivo)	Tooth mousse with CPP-ACP, Fluoride toothpaste	CPP-ACP-containing remineralizing agent significantly reduced dental sensitivity in MIH patients.
5	Efficacy of desensitizing products containing 8%	Hypersensitivity (to evaporative and	Single in-office treatment with 8% arginine and	The 8% arginine and calcium carbonate

	arginine and calcium carbonate for hypersensitivity relief in MIH-affected molars: an 8-week clinical study (2017) [21]	tactile stimuli, in vivo)	calcium carbonate desensitizing paste, followed by 8 weeks of twice-daily brushing with 8% arginine, calcium carbonate toothpaste (1450 ppm fluoride) and sensitive toothbrush, plus corresponding mouthwash	treatment effectively reduced hypersensitivity over the 8-week trial.
6	Effect of fluoride varnish on enamel remineralization in anterior teeth with molar incisor hypomineralization (2016) [55]	Remineralization (assessed via quantitative light-induced fluorescence, in vivo)	Four applications of 5% NaF varnish (1-week intervals), Usual home care (control)	No beneficial effect on remineralization of MIH lesions in anterior teeth was observed after four fluoride varnish applications.

In the area of toothpaste research, studies have directly compared the MIH-remineralization effectiveness and sensitivity relief provided by fluoride-free hydroxyapatite toothpastes versus fluoride-containing toothpastes **(Tables 3 and 4)** [18, 25]. Researchers [22] reported in an in situ study that hydroxyapatite toothpaste achieved a notably higher percentage of remineralization than a toothpaste containing 1450 ppm fluoride [25], with mineral density assessed via microcomputed tomography [25] **(Table 3)**. Additionally, Ehlers *et al*., in a randomized controlled trial involving MIH patients, found that participants using hydroxyapatite toothpaste generally experienced lower sensitivity compared with those using toothpaste containing 1400 ppm fluoride [18] **(Table 4)**, with pain responses to tactile stimuli measured on the Wong-Baker FACES Pain Rating Scale ranging from 0 (no pain) to 10 (worst pain) [18].

Table 3. Overview of outcomes from a randomized, double-blind, crossover, in situ study comparing the MIH-remineralization performance of fluoride-free hydroxyapatite toothpaste with a toothpaste containing 1450 ppm fluoride [25]. Mineral density was evaluated using microcomputed tomography, and the hydroxyapatite toothpaste demonstrated a practically significant higher mean percentage of remineralization than the fluoride toothpaste (mean ± standard deviation) [25].

Outcome	Hydroxyapatite Toothpaste	Fluoride Toothpaste
Combined data	26.02 ± 20.68	14.64 ± 9.60
Etched	29.26 ± 22.99	16.83 ± 9.97
Unetched	16.62 ± 5.74	10.62 ± 8.13

Table 4. Overview of findings from a randomized controlled trial evaluating the effectiveness of hydroxyapatite toothpaste in reducing MIH-related sensitivity in children, compared to a toothpaste containing 1400 ppm fluoride [18]. Sensitivity in response to tactile stimuli was assessed using the Wong-Baker FACES Pain Rating Scale, ranging from 0 (no pain) to 10 (worst pain). Children using the hydroxyapatite toothpaste generally experienced lower sensitivity than those using the fluoride toothpaste [18].

Toothpaste	ITT Population	PP Population
Hydroxyapatite	Mean: 2.6 [95%CI]: 1.5–3.7	Mean: 2.6 [95%CI]: 0.9–4.3
Fluoride	Mean: 3.4 [95%CI]: 2.4–4.4	Mean: 3.1 [95%CI]: 1.7–4.5

ITT: intention-to-treat; PP: per protocol; CI: confidence interval.

Discussion

Molar incisor hypomineralization (MIH) is a widespread developmental dental disorder that poses significant challenges for patients due to its high treatment demands. Despite this, no comprehensive review has yet summarized all remineralization systems as non-invasive treatment options for MIH. Teeth affected by MIH exhibit reduced mineral density and hardness relative to healthy teeth, making interventions aimed at enhancing remineralization a logical therapeutic approach. Most research in this area has emerged recently, with the earliest study dating back to 2011 **(Table 1)**, reflecting a growing scientific interest in MIH. Existing studies demonstrate that various calcium phosphate compounds can effectively promote remineralization in MIH-affected teeth **(Table**

1). These compounds function by creating a calcium- and phosphate-ion-rich environment on the enamel surface, which facilitates crystal growth [57]. Beyond remineralization, calcium phosphates have also been shown to alleviate tooth sensitivity associated with MIH [36], as evidenced by studies using fluoride-free hydroxyapatite toothpaste [18] and CPP-ACP tooth mousse [20].

Calcium phosphates are versatile and can be incorporated into multiple oral care products, including toothpastes [25, 26, 58], mouth rinses [31, 32], and oral gels [59]. One notable advantage is their biomimetic nature [40], allowing for higher therapeutic doses without toxicity risks, unlike fluoride [29]. These compounds are safe for all age groups, including children, since accidental ingestion merely releases harmless calcium and phosphate ions in the stomach [40]. The majority of calcium phosphate-based oral products rely on either CPP-ACP or hydroxyapatite (HAP). However, CPP-ACP has limitations for patients with milk protein allergies, as its casein phosphopeptides (CPP) are derived from cow milk [5, 60], and it is primarily delivered as a tooth mousse alongside toothpaste. In contrast, HAP is more flexible in application, being suitable for incorporation into oral gels in addition to toothpaste [18, 25, 29, 61-63].

Comparing findings across studies **(Table 1)** is challenging due to the variety of techniques used to assess remineralization in MIH teeth, including microcomputed tomography [25], transverse microradiography [23], Vickers microhardness testing [42], laser fluorescence [46–48], Raman microscopy [43], energy-dispersive spectroscopy [44], and scanning electron microscopy [28]. In clinical studies, laser fluorescence was most commonly employed to evaluate in vivo remineralization **(Table 1)**. Standardizing analytical methods in future research would facilitate more reliable comparisons of outcomes.

Despite MIH's high prevalence [2] and the recognized importance of preventive strategies [64], only 19 studies have investigated remineralization of MIH lesions across various active oral care ingredients, including fluoride. Among these, merely six studies specifically focused on toothpaste (three on remineralization and three on reducing MIH-related sensitivity), even though toothpaste is a cornerstone of at-home oral care [65, 66] **(Table 2)**. This highlights a significant research gap, emphasizing the need for additional studies, particularly clinical trials. A recent review by Gevert *et al*. similarly concluded that evidence supporting existing MIH treatment options, both at home and in-office, remains limited [22].

Conducting clinical studies on MIH remineralization poses challenges because high-resolution techniques like scanning electron microscopy or transverse microradiography cannot be performed directly in vivo. In this context, in situ studies offer a valuable alternative, wherein participants wear intraoral appliances containing MIH-affected enamel blocks during routine product use. After the study period, these blocks are retrieved and analyzed ex vivo using high-resolution methods such as microcomputed tomography [25, 44]. Overall, combining in vivo, in situ, and in vitro approaches represents the most promising strategy for advancing research on MIH-focused oral care products.

Although fluoride is commonly recommended for patients with MIH [5], the clinical evidence supporting its effectiveness in remineralizing MIH-affected teeth remains very limited. Only a few studies have evaluated fluoride formulations, and these have largely focused on fluoride varnishes [25, 44-49, 54, 55] **(Tables 1 and 2)**. For instance, Restrepo *et al*. reported that four applications of 5% sodium fluoride varnish did not result in significant remineralization compared to standard home care [55].

Conversely, an in situ clinical study summarized in **Table 3** demonstrated that using hydroxyapatite toothpaste daily for 14 days led to substantial remineralization of MIH lesions [22]. This suggests that regular oral hygiene with hydroxyapatite toothpaste can effectively restore MIH-affected enamel. Supplementing this regimen with hydroxyapatite-based gels or mouthwashes may further enhance the remineralization process. Because MIH teeth have lower mineral density and are more vulnerable to mechanical wear, using a toothbrush with soft bristles is advisable. Additionally, abrasive whitening toothpastes designed for stain removal should be avoided to prevent further enamel damage.

The findings of this review provide a valuable foundation for future research in MIH-focused preventive oral care. As highlighted, research on preventive strategies for MIH is still limited. Nevertheless, compared to other daily oral care approaches, a greater number of studies have explored calcium phosphate-based treatments, offering stronger clinical evidence for their efficacy in remineralizing MIH-affected teeth **(Tables 1 and 2).**

Conclusion

Molar incisor hypomineralization (MIH) represents a global dental challenge, imposing significant treatment needs and a considerable health burden on affected patients. Research interest in MIH has grown,

particularly in recent years. Individuals with MIH require specialized daily oral care, as their teeth exhibit reduced mineral density, are more susceptible to caries, prone to breakdown, and often highly sensitive.

This review highlights that daily oral care products containing calcium phosphates—such as calcium glycerophosphate, casein phosphopeptide-amorphous calcium phosphate (CPP-ACP), and hydroxyapatite—can effectively promote remineralization in MIH-affected teeth. In contrast, studies on fluoride for MIH remineralization are sparse and primarily involve high-concentration varnishes rather than standard toothpaste. Beyond remineralization, CPP-ACP and hydroxyapatite also help reduce MIH-associated tooth sensitivity. All calcium phosphate compounds are safe for use in daily oral care across all age groups. Unlike CPP-ACP, hydroxyapatite can be readily incorporated into toothpaste formulations, making hydroxyapatite-based products particularly well-suited for routine oral care in MIH patients.

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