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Review

Treatment Strategies for Incisors of Children Affected by Molar Incisor Hypomineralization: A Narrative Review

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Abstract: Today, molar incisor hypomineralization (MIH), which affects approximately one in seven children, is defined as a hypomineralized developmental enamel defect that often impacts at least one permanent first molar and frequently affects permanent incisors as well. Symptoms and signs include demarcated opacities of various colors, post-eruptive enamel deterioration, atypical caries and restorations, hypersensitivity, tooth loss due to MIH, and difficulty in achieving anesthesia. A detailed review of the scientific literature shows that there are many studies evaluating different treatment approaches for permanent first molars affected by MIH. On the other hand, there are very few scientific studies evaluating treatment approaches for affected incisors in patients with MIH. Most of these studies consist of case reports or series. White/creamy and/or yellow/brown demarcated opacities are commonly observed in affected incisors in patients with MIH. While these opacities increase the susceptibility of enamel to deterioration and dental caries, they also cause aesthetic problems and related psychosocial consequences. Treatment methods, such as resin infiltration, microabrasion, and/or dental bleaching, have been proposed for aesthetic and restorative purposes in affected incisors in patients with MIH. Additionally, various approaches to increase mineral content and relieve hypersensitivity have been recommended. The number of randomized controlled and prospective studies is quite low, but many case reports and case series have been encountered. The purpose of this review was to provide a comprehensive overview of the different treatment management modalities for permanent incisors affected by MIH. As a result, while resin infiltration, dental bleaching, microabrasion, and/or etch–bleach–seal techniques are preferred for aesthetic and restorative purposes in these teeth, it has been observed that agents containing casein phosphopeptide amorphous calcium phosphate, casein phosphopeptide amorphous calcium fluoride phosphate, fluoride, and calcium glycerophosphate increase the mineral content. Additionally, studies have reported that ozone and low-level laser therapy, in addition to these remineralizing agents, reduce hypersensitivity in these teeth. Although the findings of this review indicate that the level of evidence for current approaches is not high, clinicians may prefer one or more of the treatment approaches mentioned in this article based on experience and patient expectations.

Keywords: aesthetic treatment; developmental enamel defects; hypomineralization; incisors; MIH; microabrasion; molar incisor hypomineralization; remineralization; resin infiltration; treatment

Citation: Sezer, B.; Çarıkçıoğlu, B. Treatment Strategies for Incisors of Children Affected by Molar Incisor Hypomineralization: A Narrative Review. *Oral* **2024**, *4*, 74–89. https://doi.org/10.3390/oral4010007

Academic Editor: Giuseppina Campisi

Received: 1 November 2023
Revised: 18 January 2024
Accepted: 22 January 2024
Published: 1 February 2024

1. Introduction

Molar incisor hypomineralization (MIH), which was first introduced by Weerheijm, Jälevik, and Alaluusua in 2001, describes qualitative developmental enamel defects of a hypomineralized nature in which at least one permanent first molar is affected, and often permanent incisors are affected as well [1]. Until 2001, the condition, which has various definitions, such as cheese molars, idiopathic enamel hypomineralization, and non-fluoride developmental enamel defect, had largely gone undocumented outside of Sweden, where it was first described a long time ago [2]. Due to the increasing incidence of MIH, it has become mandatory to report and calculate its prevalence in different countries and regions

and worldwide. Its prevalence has been reported to vary from 2.8% to 40% in different countries and regions. The main reason for such a wide range in prevalence is thought to be the lack of information and confusion about the diagnosis of MIH [3,4]. In addition, the effect of environmental and genetic factors in different birth cohorts may contribute to this variation [3]. Despite differences between regions, three recent comprehensive systematic reviews and meta-analyses show that the prevalence of MIH is 13.1% [5], 14.2% [6], and 13.5% [7] worldwide. This clearly indicates that approximately one in seven people worldwide is affected by MIH [8].

While the etiology of MIH is not fully elucidated, it is thought to be caused by a variety of prenatal, perinatal, and postnatal factors, as well as environmental and genetic factors [9]. Prominent factors include maternal illnesses during pregnancy, medication usage, radiation exposure, stress, and smoking. Additionally, other factors, such as preterm birth, low birth weight, birth hypoxia, and cesarean section delivery, may contribute to MIH. In addition, postnatal factors, especially diseases experienced by the child, especially in the first three years of life, medication usage, especially antibiotics, and prolonged breastfeeding, are notable [9–15]. Furthermore, it is hypothesized that some factors, such as environmental pollution due to climate change and the presence of various elements in the air and water above a certain level, may also contribute to MIH [9,14,16–18]. Especially in recent years, there have been many studies investigating genetic and epigenetic factors in the etiology of MIH. It is thought that different genes and epitopes may be involved in causing MIH [9,14,19–24].

The diagnosis of MIH is of utmost importance for clinicians to plan appropriate treatment. In this context, during the transition period from primary dentition to mixed dentition, it is crucial to diagnose the condition for the prognosis of the tooth and to maintain control of the situation with appropriate preventive approaches while the permanent first molars are erupting [25–27]. In particular, the age of eight years, when the permanent first molars have fully erupted coronally, is considered the ideal time for diagnosis [25,28]. Although the clinical appearance of MIH varies according to its severity, diagnostic criteria typically include white/creamy and/or yellow/brown demarcated opacities, post-eruptive enamel breakdown, atypical caries and restorations, and tooth loss due to MIH [28,29]. Lesions larger than one millimeter are used for diagnosis [29].

It has been reported that 27.4% of teeth affected by MIH need treatment due to pain, hypersensitivity, dental caries, or post-eruptive enamel breakdown [5]. Different approaches have been used to treat permanent first molars affected by MIH. Although various caries removal techniques and restorative materials have been the subject of many studies, tooth extraction followed by orthodontic treatment is also an option [30–35]. The process of deciding on treatment is quite complex. It depends on the tooth, the oral cavity, the occlusion, the expectations of the patient and their parents, the cooperation of the patient, and many other factors. Hypersensitivity-relieving applications, fissure-sealing applications, restorative materials, such as glass ionomers, composite resins, stainless steel crowns, and prosthetic crowns, and restorative techniques, such as selective caries removal, chemomechanical caries removal, stepwise caries removal, and the Hall technique, have been tried on molars [30–35]. On the other hand, the number of studies evaluating treatment modalities in affected incisors in patients with MIH is very limited [8,31]. Although current studies have focused on relieving hypersensitivity, providing remineralization, and improving aesthetics, recent systematic reviews and meta-analyses highlight the difficulty in determining the most accurate treatment approach due to the small number of these studies [31]. The most common white/creamy and/or yellow/brown demarcated opacities in affected incisors in patients with MIH cause enamel weakness and can lead to psychological development issues due to aesthetic problems [8,36]. There is a need for more studies evaluating treatment approaches in affected incisors in patients with MIH [8]. Therefore, the purpose of this review is to present a comprehensive overview of the different treatment modalities and outcomes in affected incisors in patients with MIH.

2. Search Strategy

Four databases (PubMed, ScienceDirect, Google Scholar, and Scopus) were searched by two well-trained academician pediatric dentists (B.S. and B.Ç.) using medical subject headings (MeSH terms) and a free hand search up to 31 July 2023. The search terms used were molar incisor hypomineralization, molar incisor hypomineralisation, molar-incisor hypomineralization, molar-incisor hypomineralisation, demarcated opacities, post-eruptive enamel breakdown, MIH, MIH treatment, MIH management, MIH incisors, MIH-affected incisors, and MIH affected incisors. The articles obtained as a result of all of these search strategies were reviewed, and articles relating to permanent first molars were excluded from this study. Only original research articles, case reports, and case series related to the treatment of incisors affected by MIH were included in this study. The eligibility of the articles was determined by reading the title and the abstract and, where necessary, by examining the full text of the articles. As a result, 40 articles were selected for review. The full texts of five of these articles could not be accessed. A total of 35 articles were examined in detail by both examiners and included in this review (Figure 1: Flowchart of study selection according to PRISMA statement). The 35 articles included in this study are shown in Table 1.

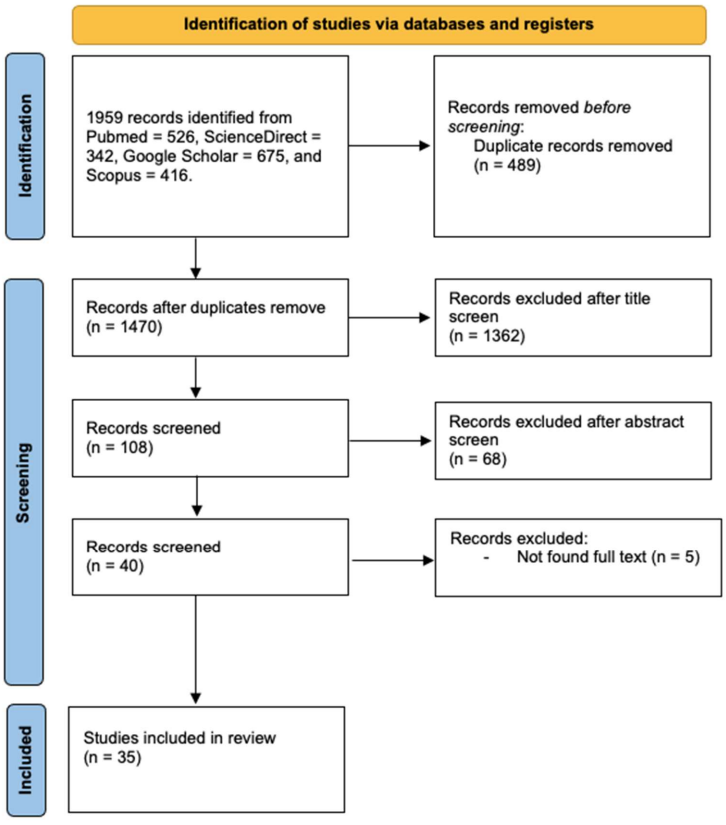

Figure 1. Flowchart of study selection according to PRISMA statement.

3. Treatment Strategies for Incisors Affected by Molar Incisor Hypomineralization

3.1. Restorative and Aesthetic Approaches

Enamel white spot lesions and demarcated opacities are optical alterations that compromise the aesthetic of the smile. They can result from various factors, such as demineralization and enamel formation defects [37,38]. White spot lesions, for which treatment approaches are similar to those for affected incisors in patients with MIH, are the first visual changes in enamel that differ in pathogenesis, and they are mainly caused by pathogenic plaque accumulation [39]. Therefore, in order to understand the character of the demarcated opacities in enamel affected by MIH, it is important to also identify and understand white spot lesions. Various treatment approaches have been described in the scientific literature

to prevent lesion progression, cavitation progression, and dyschromia appearance in white spot lesions observed due to plaque accumulation during and after treatment, especially in patients receiving orthodontic treatment [39–41]. White spot lesions should be managed using a multifactorial approach. The most important strategy is to prevent demineralization and biofilm formation [42]. Certain approaches, such as professional fluoride applications, use of agents containing CPP-ACP and CPP-ACFP, microabrasion, macroabrasion, and resin infiltration, are preferred in the management of white spot lesions [39,42]. It has been reported that the most effective approach among these treatment options is resin infiltration [39,42]. Studies show that the resin infiltration technique is immediately effective in the aesthetic treatment of white spot lesions and that the camouflage effect continues one year after the treatment [43]. Resin infiltrants are agents that penetrate the pores of demineralized and/or hypomineralized enamel in a capillary manner, altering the refractive index of the structure of the tooth and partially or completely masking the appearance of the white spot lesions or demarcated opacities [44]. Understanding changes in enamel affected by MIH is crucial for its management [45]. Generally, MIH-affected enamel exhibits decreased mineral content and quality (low calcium and phosphorus). Compared to healthy enamel, MIH-affected enamel has lower hardness and elastic modulus and higher protein content, carbon, and carbonate concentration [46,47]. Studies indicate higher protein content in yellow and brown lesions, with ameloblastin found only in brown lesions. Concentrations of serum albumin, alpha-1-antitrypsin, and antithrombin III are higher in yellow and brown lesions compared to white lesions [48].

There have been several studies evaluating the effect of resin infiltration treatment on affected incisors in patients with MIH. Attal et al. [49] treated demarcated opacities using the deep infiltration technique due to the failure of the superficial infiltration technique in MIH cases. The alcohol used in the deep infiltration technique serves as an optical preview of the effectiveness of the infiltration. Thus, it provides a more minimally invasive solution for white lesion treatment without the need for additional chemical and physical procedures [49]. In another study [50], 76 anterior teeth with demarcated enamel opacities were treated with the resin infiltration technique. After resin infiltration, the color change in the lesions was evaluated visually and spectrophotometrically. Resin infiltration treatment was found to significantly improve the aesthetics of hypomineralized enamel [50]. Bresica et al. [51] assessed the clinical effectiveness and efficacy of resin infiltration technique for treating mild to moderate anterior demarcated hypomineralized lesions in 33 patients (24 of them with MIH). The study results showed that the superficial infiltration technique successfully treated teeth with mild MIH in a single session [51]. In addition, another study [52] evaluated color changes in 22 incisors with Grade I MIH before and after resin infiltration. A significant reduction in white/creamy lesions was observed immediately and six months after resin infiltration. The results showed that the resin infiltration method can successfully achieve short- and long-term aesthetic treatment of teeth with mild MIH [52]. In a case report by Farias et al. [53], a female patient had a diffuse white demarcated opacity on her permanent right central incisor due to MIH. With the resin infiltration technique, the lesion was masked and treated aesthetically without the need for mechanical abrasion of the tooth. In a case report [54], the resin infiltration technique was applied to a female patient who was diagnosed with hypomineralization due to MIH in her upper central and lateral incisors. Following the resin infiltration procedure applied to the hypomineralized areas, the lesions were masked in a minimally invasive way, and an aesthetic improvement was achieved. In the study by Kim et al. [55], clinical photographs were taken before, immediately after, and one week after resin infiltration treatment of 20 teeth with developmental enamel defects in the upper anterior teeth, and color changes were evaluated using the CIELAB color measurement system. The masking effect of demarcated lesions was not effective in some cases. It was concluded that the depth and activity of the demarcated opacity may influence aesthetic improvement [55]. White lesions on the upper central incisors of a patient with MIH were assessed using transillumination to measure lesion depth before resin infiltration. With this method, the edges of the lesion

are also exposed, and it has been reported that it can be used to monitor the progression of resin infiltration. The enamel layer on the white lesions was gently removed, and the standard resin infiltration method was applied. After one week, the white lesions became aesthetically compatible with the teeth [56]. Gianetti et al. conducted two studies on enamel demarcated white lesions. In their first study [57], the deep resin infiltration treatment was applied to a patient whose upper incisors were hypomineralized due to MIH. Mechanical abrasion was performed on the affected enamel surface before resin infiltration. After the resin infiltration treatment, composite restoration was applied to the abraded enamel surface. In another study by Gianetti et al. [58], 17 cases with superficial hypomineralized defects were followed for 12 months after resin infiltration treatment. A partial reduction in the appearance of demarcated white lesions was observed in eight MIH cases, while white lesions disappeared completely in only one case. At the end of their studies, they emphasized that it may be necessary to approach patients with MIH with more invasive techniques [56,57]. In a study [38] evaluating the clinical success of the treatment by applying microabrasion and resin infiltration treatment on 29 upper incisors of 23 children with MIH, the images of the related teeth were taken before and six months after the treatment. The surface areas of demarcated white opacities before and after treatment were compared, and the results showed that the size and brightness of lesions can be reduced with minimally invasive treatment of the incisors [38]. In another study [59], 51 pediatric patients with at least one affected incisor with MIH were divided into three groups. These included a group that received fluoride varnish, another group that received fluoride varnish after enamel abrasion with 37% phosphoric acid, and a third group that received resin infiltration treatment. The subjects were followed for 18 months. The results showed that resin infiltration treatment was a more effective treatment than fluoride varnish application in reducing the risk of enamel breakdown [59]. In one study [60], resin infiltration method was applied to 58 anterior incisors in 37 patients with MIH. The color changes of the enamel before and after the treatment were evaluated using a spectrophotometer, and the dimensional change of the lesion was evaluated by comparing the digital photographs. The results showed that resin infiltration provided significant long-term aesthetic improvement for MIH lesions in incisors [60]. The surface layer of type 1 and type 2 demarcated opacities on 32 upper incisors with MIH was removed using a dental drill in another study [61]. Images were obtained before, during, and after the resin infiltration application. MIH lesion type and ethanol application are important factors in deciding the application time of the resin infiltration. In a study [62] on the psychosocial impact and oral-health-related quality of life (OHRQoL) of the aesthetic treatment of hypomineralized enamel lesions on the affected incisors in patients with MIH, the resin infiltration method was applied alone or in combination with microabrasion, dental bleaching, or composite resin restoration methods. It was found that the reduced visibility of enamel opacities had a positive effect on the improved OHRQoL of children and their psychosocial status [62]. In a study [63] on masking demarcated opacities with resin infiltration and fluoride varnish application in 40 permanent incisors of 20 children with MIH, digital photographs of the relevant areas were taken before and after treatment. The resin infiltration technique was found to be significantly more effective in the aesthetic treatment of these lesions than fluoride varnish. The resin infiltration method has been applied alone or in combination with other aesthetic treatment methods. As can be read above, successful results have often been achieved. Apart from this, other treatment methods have also been tried to ensure aesthetics.

In a case report [64], a 7-year-old female patient's permanent maxillary incisors affected by MIH were restored with composite resin after the use of casein phosphopeptide amorphous calcium phosphate (CPP-ACP), fluoride toothpaste, and dental bleaching. It was concluded that dental bleaching is an effective approach before the final restoration of white-yellow hypomineralized defects [64]. In another case report [56], the upper incisors of a patient affected by MIH were bleached using hydrogen peroxide and carbamide peroxide after the use of CPP-ACP. It has been reported that the combined use of hydro-

gen peroxide, in low concentrations, and CPP-ACP prior to dental bleaching produces favorable results in terms of aesthetics. Furthermore, successful results were obtained at the end of the five-month treatment period [65]. In another case [66] of MIH followed for 11 years, treatments involving composite resin restoration, microabrasion, and dental bleaching were applied to yellow-brown severe demarcated opacities in anterior teeth at different time intervals. This case report highlights one of the most important problems in teeth affected by MIH: the frequent loss of restorations. Although the combined treatment methods improved the aesthetic appearance, the patient visited the clinic for dental treatment 36 times within an 11-year period [66]. In another case report [67], a patient with demarcated opacities in permanent mandibular incisors affected by MIH had the lesions initially treated with microabrasion. Because this procedure was unsuccessful, the treatment was completed with direct composite veneers. Another treatment method for dental aesthetics is the etch–bleach–seal technique, consisting of three stages. Firstly, the tooth is prepared after isolation. Secondly, dental bleaching is sought using 37% phosphoric acid and 5% sodium hypochlorite. Finally, the tooth is sealed with a flow sealant [68]. In a case report describing three cases [69], this technique was used alone, in combination with microabrasion, or in combination with resin infiltration. It has been reported as an effective technique when used with other methods in treating yellow-brown demarcated opacities. In a randomized controlled clinical study [70], 43 teeth affected by MIH were divided into two groups. One group only received microabrasion, while the other group underwent microabrasion followed by casein phosphopeptide amorphous calcium fluoride phosphate (CPP-ACFP). Photographs of the teeth were taken before treatment, immediately after treatment, and six months after treatment. Photographic evaluation was performed using the CIELAB color scoring method. As a result, it has been reported that the use of CPP-ACFP following microabrasion creates more acceptable results [70]. In another case report [71], violet LED and infrared laser were used to photo-accelerate microabrasion and low-concentration dental bleaching for a patient with demarcated opacities due to MIH in their upper incisors. As a result of three-year follow-up, it was reported that an aesthetic look was achieved, and the patient's wellbeing improved. It is thought that this method can be a conservative alternative to eliminating the aesthetic problems related to MIH. Hasmun et al. [72] retrospectively questioned appearance-related satisfaction in children aged 7–16 years who had enamel defects in anterior teeth, some of which were related to MIH and were treated with microabrasion with/without additional composite resin. Researchers have reported that simple non-invasive dental treatment has a positive effect on appearance-related satisfaction [72].

3.2. Approaches to Increasing Mineral Content

The rise of the concept of minimal interventional dentistry in recent years has moved researchers away from traditional methods. Improvements in adhesive dentistry, alongside advancements in the technology of remineralization, have relegated interventional approaches into a secondary consideration for lesions without cavitation. In this context, approaches to increasing mineral content have been investigated in the treatment of both white spot lesions and hypomineralized lesions observed in MIH and other developmental enamel defects [73,74]. In two different randomized in vivo studies by Sezer et al. [75,76], the effects of different remineralization agents on white/creamy or yellow/brown demarcated opacities on the incisors affected by MIH were evaluated using the laser fluorescence method. As a result of the first study [75] using calcium glycerophosphate (CaGP), CPP-ACFP, and fluoridated toothpaste (as the control group), it was reported that agents containing CaGP and CPP-ACFP in addition to routine oral hygiene practices increased the mineral content of the lesions. In the second study [76], patients used remineralization agents containing CaGP and CPP-ACFP in a cross-over design. It was reported that both agents increased the mineral content and provided remineralization after three months, regardless of the cross-over design. Restrepo et al. [77] evaluated the remineralization effect of 5% sodium fluoride (NaF) varnish on anterior teeth affected by MIH using quantitative

light-induced laser fluorescence. As a result of the study, in which usual home care was chosen as the control group, it was observed that there was no statistically significant difference between the two groups [77]. Singh et al. [78] evaluated the remineralization effect of CPP-ACP-containing agents and professional fluoride varnishes on both permanent first molars and permanent incisors affected by MIH using laser fluorescence. Mineral density was measured 15 days before and after treatment. It was concluded that both agents provided remineralization in teeth affected by MIH, regardless of each other [78]. In a pilot study [79], the remineralization efficiency of self-assembling peptide in incisors affected by MIH was evaluated using laser fluorescence. The significant decrease in laser fluorescence values one month after application led to the conclusion that self-assembling peptides can be used in the remineralization of hypomineralized lesions [79]. Biondi et al. [80] evaluated the effects of 5% NaF varnish, 5% NaF varnish with tricalcium phosphate, and CPP-ACP on increasing the mineral density of mild and moderate demarcated opacities affected by MIH. Measurements were taken at baseline, day 15, day 30, and day 45 using laser fluorescence. According to the results, 5% NaF varnish with tricalcium phosphate is more effective in mild lesions, while 5% NaF varnish is more effective in moderate lesions [80]. In a case report [81], zinc hydroxyapatite paste was used to both improve aesthetics and relieve hypersensitivity in a child diagnosed with MIH. Over the observation period, all negative symptoms disappeared. And, it has been reported that the basis of this situation is the remineralization capacity of the relevant agent [81].

3.3. Approaches to Relieving Hypersensitivity

Although the mechanism that plays a role in the hypersensitivity of teeth affected by MIH is not fully understood, it is thought that the more porous enamel facilitates the invasion of bacteria into the dentinal tubules and causes subclinical pulp inflammation and exacerbates hypersensitivity. This tissue inflammation may cause some morphological and cytochemical changes in sensory neurons, causing sensitization of these nerve fibres. Because of MIH, teeth may suffer from hypersensitivity ranging from mild to severe. Such sensitivity can be triggered by toothbrushing, consuming hot and/or cold drinks, and consuming acidic foods. This situation causes pain, restlessness, and a decrease in the quality of life of the affected individuals [82–85]. In the literature, the number of studies on the elimination of hypersensitivity in anterior teeth affected by MIH is very low. In a study [86] including 66 children diagnosed with MIH, they were randomly divided into three groups. Laser, fluoride varnish, and laser with fluoride varnish were used to eliminate hypersensitivity in both permanent first molars and permanent incisors. Evaluations were made after 48 h and one month later in the laser group; after one, two, three, and four weeks in the fluoride varnish group, and after 48 h and one, two, three, and four weeks in the third group. It has been reported that laser and fluoride varnish have similar effects. While the laser showed an immediate effect, fluoride varnish showed a late-onset effect. It has been suggested that low-level laser therapy be used to relieve hypersensitivity in teeth affected by MIH given the analgesic efficacy of both treatments [86]. Ozgül et al. [87] evaluated fluoride, CPP-ACP, and CPP-ACFP in the presence and absence of ozone therapy in the relief of hypersensitivity in incisors affected by MIH. In a study in which the evaluation was made using the Visual Analogue Scale of Pain, it was observed that hypersensitivity decreased significantly in all groups. While CPP-ACP paste was found to be more effective, ozone therapy prolonged the effect of CPP-ACP [87]. In a case [88] diagnosed with severe MIH in which the hypersensitivity level was measured with a Visual Analogue Scale of Pain by applying low-level laser therapy in continuous mode, it was reported that laser therapy was effective in reducing hypersensitivity and increased the patient's oral-health-related quality of life. A case report by Paschoal et al. [89] investigated the effect of photobiostimulation on hypersensitivity in a patient whose incisor and molar teeth were both affected by MIH. As a result, it was reported that this treatment method improved the quality of life and reduced hypersensitivity in the relevant case.

Table 1. Author/s, publication year, study type, sample size, and technical/interventional characteristics of the 35 articles included in this study.

Study Number	Authors	Publication Year	Study Type	Sample Size	Technique/Intervention	Outcome
1 [49]	Attal et al.	2014	Case series	5 patients/10 incisors	Resin infiltration	It is aesthetically promising, but caution is warranted due to the lack of long-term follow-up.
2 [50]	Mazur et al.	2018	Retrospective study	76 incisors	Resin infiltration	Enhances enamel aesthetics; visual and objective correlation observed.
3 [51]	Brescia et al.	2022	Retrospective study	33 patients/114 incisors (including fluorosis and trauma)	Resin infiltration	It is an effective treatment for mild MIH.
4 [52]	Bhandari et al.	2018	Clinical trial	22 incisors	Resin infiltration	Swift aesthetics for Grade I MIH; alternative before invasive procedures.
5 [53]	Farias et al.	2022	Case report	1 patient/1 incisor	Resin infiltration	Masks superficial white demarcated opacities; conservative, aesthetically effective treatment.
6 [54]	Mabrouk et al.	2020	Case report	1 patient/4 incisors	Resin infiltration	Minimally invasive technique eradicates white opacities effectively.
7 [55]	Kim et al.	2011	Clinical trial	12 patients/20 incisors	Resin infiltration	While the masking effect was effective in some, it was inadequate in others.
8 [56]	Marouane and Chtioui	2020	Case report	1 patient/2 incisors	Resin infiltration	Transillumination aids enamel infiltration treatment by assessing, confirming, and monitoring lesions.
9 [57]	Giannetti et al.	2018	Case report	1 patient/2 incisors	Resin infiltration	Deep infiltration can be performed to reach the limit of the lesion.
10 [58]	Giannetti et al.	2018	Clinical trial	17 patients/38 incisors	Resin infiltration	Superficial infiltration did not produce effective treatment in all cases.
11 [38]	Warner et al.	2022	Clinical trial	23 patients/29 incisors	Resin infiltration/microabrasion	Minimally invasive treatment is effective in reducing incisor opacities in children.
12 [59]	Nogueira et al.	2021	Clinical trial	51 patients/100 incisors	Resin infiltration with or without fluoride varnish and acid etching	Positively affected the structural integrity of the affected teeth by reducing the risk of enamel breakdown.
13 [60]	Altan and Yilmaz	2023	Clinical trial	37 patients/58 incisors	Resin infiltration	Micro-invasively effective treatment.
14 [61]	Marouane and Manton	2021	Clinical trial	17 patients/32 incisors	Resin infiltration	MIH lesion type and ethanol test predict time for infiltrating anterior teeth.
15 [62]	Hasmun et al.	2020	Longitudinal interventional study	103 patients	Resin infiltration/microabrasion/dental bleaching/composite resin restoration	Minimally invasive treatments can provide good clinical and psychosocial outcomes in children.

Table 1. *Cont.*

Study Number	Authors	Publication Year	Study Type	Sample Size	Technique/Intervention	Outcome
16 [63]	ElBaz and Mahfouz	2017	Clinical trial	20 patients/40 incisors	Resin infiltration/fluoride varnish	Resin infiltration is more successful at masking white opacities than fluoride varnish.
17 [64]	Baroni et al.	2019	Case report	1 patient/2 incisors	CPP-ACP/fluoride toothpaste/dental bleaching/composite resin restoration	Calcium phosphate may improve etching and bonding; bleaching reduces incisor defects pre-restoration.
18 [65]	Mastroberardino et al.	2012	Case report	1 patient/4 incisors	CPP-ACP/dental bleaching	The combined use of CPP-ACP and hydrogen peroxide is successful in treating white opacities without the need for invasive treatment.
19 [66]	Vieira et al.	2023	Case report	1 patient/2 incisors	Dental bleaching/microabrasion/composite resin restoration	The initial use of minimally invasive techniques contributes to the final treatment being as conservative as possible.
20 [67]	Pessôa et al.	2018	Case report	1 patient/4 incisors	Microabrasion/composite veneers	Adequate aesthetics were achieved after the conservative approach.
21 [69]	Prud'homme et al.	2017	Case series	3 patients/9 incisors	Microabrasion/resin infiltration/etch–bleach–seal technique	A non-invasive approach to the treatment of anterior yellow-brown opacities, but definitive aesthetic success may not be achieved.
22 [70]	Bhandari et al.	2019	Clinical trial	43 incisors	Microabrasion/CPP-ACP	Microabrasion and remineralizing agent enhance aesthetics of white opacities over time.
23 [71]	Costa et al.	2021	Case report	1 patient/4 incisors	Microabrasion/dental bleaching	A minimally invasive combination—microabrasion and low-concentration gel with light—enhanced aesthetics.
24 [72]	Hasmun et al.	2018	Retrospective study	93 children	Microabrasion with or without composite resin restoration	Minimally invasive dental treatment to reduce the visibility of enamel opacities in MIH can have a positive impact on children's wellbeing.
25 [75]	Sezer and Kargül	2022	Clinical trial	53 patients/401 incisors	CaGP/CPP-ACFP/fluoride toothpaste	The use of two mineral-containing agents also improved lesions in hypomineralized anterior teeth with demarcated opacities.

Table 1. *Cont.*

Study Number	Authors	Publication Year	Study Type	Sample Size	Technique/Intervention	Outcome
26 [76]	Sezer et al.	2022	Clinical trial	22 patients/167 incisors	CaGP/CPP-ACFP	CPP-ACFP and CaGP had a positive effect on decreasing hypomineralization in MIH-affected enamel for a three-month period.
27 [77]	Restrepo et al.	2016	Clinical trial	51 patients/51 incisors	Fluoride varnish/home care	Fluoride varnish application was not effective in remineralization of the lesions.
28 [78]	Singh et al.	2021	Clinical trial	30 patients	CPP-ACP/fluoride varnish	Both agents are equally effective in providing remineralization.
29 [79]	Singh et al.	2021	Clinical trial	10 incisors	Self-assembling peptide	The agent may be an alternative, viable, preventive treatment option for remineralization of hypomineralized lesions.
30 [80]	Biondi et al.	2017	Clinical trial	55 patients/92 incisors	Fluoride varnish with or without tricalcium phosphate or CPP-ACP	Success in the treatment of lesions increases by adding remineralization agents to fluoride varnish.
31 [81]	Solinas et al.	2021	Case report	1 patient/4 incisors	Hydroxyapatite-based paste	The agent improves aesthetics and also eliminates hypersensitivity.
32 [86]	Muniz et al.	2020	Clinical trial	66 patients/99 incisors	Laser/fluoride varnish	Low-level laser therapy desensitizes teeth with MIH, and its combination with fluoride increases its effectiveness.
33 [87]	Ozgül et al.	2013	Clinical trial	33 patients/92 incisors	Ozone/fluoride varnish/CPP-ACP/CPP-ACFP	CPP-ACP paste was found to be more effective, and ozone therapy prolonged the effect of CPP-ACP paste.
34 [88]	da Silva et al.	2022	Case report	1 patient/5 incisors	Low-level laser therapy	Low-level laser therapy is indicated for the treatment of hypersensitivity and improving oral-health-related quality of life.
35 [89]	Paschoal et al.	2021	Case report	1 patient/3 incisors	Diode laser/fluoride varnish	Diode laser and fluoride varnish reduce hypersensitivity and increase oral-health-related quality of life.

CPP-ACP: casein phosphopeptide amorphous calcium phosphate; CPP-ACFP: casein phosphopeptide amorphous calcium fluoride phosphate; CaGP: calcium glycerophosphate; MIH: molar incisor hypomineralization.

4. Discussion

It has been found that MIH, on which many studies have been conducted since its first definition, is associated with hypersensitivity, difficulty in obtaining adequate anesthesia, atypical dental caries and atypical restorations, post-eruptive enamel breakdown, reduced bond strength of resin-containing restorative materials, aesthetic problems, and decreased quality of life. Treatment options range from prevention and restoration to extraction and potential orthodontic treatment after extraction. However, the process of deciding on the type of approach is quite complex. The main factors to consider are the patient's cooperation, the developmental stage of the teeth, and the severity of the defect. Moreover, the child's psychosocial status, additional abnormalities, and the preferences of both the patient and parent should also be considered. For affected incisors in patients with MIH that require treatment, options should be chosen that will help reduce sensitivity and improve aesthetics while preserving as much healthy dental tissue as possible.

Despite the lack of evidence and the number of studies in the literature, the treatment options described anecdotally in this article can be considered for the treatment of demarcated opacities in affected incisors in patients with MIH. However, it is emphasized that more robust clinical studies with longer follow-up periods are needed to be more confident in the use of these approaches. Resin infiltration, microabrasion, the etch–bleach–seal technique, dental bleaching, and composite resin veneers can be used as minimally invasive aesthetic and restorative approaches for anterior teeth. Certain products, such as CaGP, CPP-ACP, CPP-ACFP, and fluoride varnish, can be used to increase the mineral density. Furthermore, hypersensitivity relief can be obtained with fluoride varnishes, low-level laser therapy, ozone, CPP-ACP, and CPP-ACFP.

In a systematic review written by Lygidakis in 2010 [90], which presented treatment options for teeth affected by MIH, the review emphasized that treatment options for affected incisors are limited. The review included only five articles published up to the date of publication of the review, and three of these articles were found to have been published before 2001, when MIH was officially defined. The other two articles were published in 2002 and did not clearly contain the definition of MIH. Both studies that form the basis of these articles were prospective; in one, microabrasion was applied to the hypomineralized areas of the incisors, and in the other, the etch–bleach–seal technique was applied. In another systematic review published in 2022 [31], which presented treatment modalities for teeth affected by MIH, the review stated that the treatment options for incisors were more limited compared to first permanent molars. In that review, which reported the same treatment options presented in the present review, it was emphasized that many more clinical studies should be conducted on incisors. Despite 22 years passing since its first description in 2001 and 13 years since Lygidakis' systematic review [90], the number of studies on affected incisors in patients with MIH remains very limited. The results of a comprehensive review published in 2022 [31], providing an overview of reviews on treatment modalities for MIH-affected teeth, indicate that the evidence for the treatment of MIH-affected teeth and the methodological quality of these studies range from moderate to critically low. Therefore, the evidence supporting the efficacy of therapies for MIH is limited.

5. Conclusions

Molar incisor hypomineralization, which was first described in 2001 and whose prevalence has been increasing, is considered a public oral and dental health problem. It causes restorative, aesthetic, and related psychosocial effects ranging from mild to severe in the affected molars and incisors. Although there are many studies on restorative techniques and materials in molars, the number of studies on affected incisors is very limited, and the quality of the evidence is low.

In general, resin infiltration, dental bleaching, microabrasion, and the etch–bleach–seal technique are preferred for aesthetic and restorative purposes in affected incisors in patients with MIH. Products containing CPP-ACP, CPP-ACFP, fluoride, and CaGP can be used to

increase the mineral content and provide remineralization in the affected teeth. In addition, fluoride, CPP-ACP, CPP-ACFP, ozone, and low-level laser therapy can be preferred to reduce hypersensitivity in affected incisors in patients with MIH. When clinicians encounter patients affected by MIH, they should evaluate appropriate preventive and restorative approaches by considering both the patients' aesthetic expectations and other complaints, such as hypersensitivity arising from these teeth. Although the findings of this review and the current scientific literature indicate that the level of evidence for existing approaches is not high, clinicians may prefer one or more of the treatment approaches included in this article in line with experience and the patient's expectations. Despite the use of all of these treatment methods and agents, there is a need for many prospective randomized controlled clinical studies on affected incisors in patients with MIH.

Author Contributions: Conceptualization, B.S.; methodology, B.S. and B.Ç.; formal analysis, B.S. and B.Ç.; investigation, B.S. and B.Ç.; resources, B.S. and B.Ç.; data curation, B.S. and B.Ç.; writing—original draft preparation B.S. and B.Ç.; writing—review and editing, B.S. and B.Ç.; visualization, B.S. and B.Ç.; supervision, B.S.; project administration, B.S. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: No new data were created or analyzed in this study. Data sharing is not applicable to this article.

Acknowledgments: This article is dedicated to Mustafa Kemal Atatürk, the founder of modern Türkiye, who paved the way for us to pursue science, on the centenary of the foundation of the Republic of Türkiye.

Conflicts of Interest: The authors declare no conflicts of interest.

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