Pesquisa Brasileira em Odontopediatria e Clínica Integrada 2023; 23:e220112
https://doi.org/10.1590/pboci.2023.038
ISSN 1519-0501 / eISSN 1983-4632

SCOPE REVIEW

Rehabilitation Treatment in Pediatric Patients with Molar Incisor Hypomineralization: A Scoping Review

Diana María Tituana-Yupangui[1], Odalis Jazmín Cuaspud[2], Camila Montesinos-Guevara[2]

[1]Postgraduate in Pediatric Dentistry, Eugenio Espejo Faculty of Health Sciences, UTE University, Quito, Ecuador.
[2]Center for Research in Public Health and Clinical Epidemiology, Eugenio Espejo Faculty of Health Sciences, UTE University, Quito, Ecuador.

Correspondence: Camila Montesinos-Guevara, Rumipamba and Bourgeois, Universidad UTE, Quito, Ecuador. 170147. **E-mail:** camila.montesinos@ute.edu.ec

Academic Editor: Alessandro Leite Cavalcanti

Received: 08 July 2022 / **Accepted:** 11 August 2022

How to cite: Tituana-Yupangui DM, Cuaspud OJ, Montesinos-Guevara C. Rehabilitation treatment in pediatric patients with molar incisor hypomineralization: a scoping review. Pesqui Bras Odontopediatria Clín Integr. 2023; 23:e220112. https://doi.org/10.1590/pboci.2023.038

ABSTRACT

Objective: To identify the available evidence on the different treatment types for the rehabilitation of MIH-affected teeth in children. **Material and Methods:** A search was carried out in Pubmed, Cochrane Library, Epistemonikos, Lilacs and Google Scholar. Observational studies published until June 2022 were included. Two reviewers independently screened studies and extracted data. **Results:** 1593 studies were screened and a total of 38 articles were included, which were mainly case reports published in Brazil. Most included studies concluded that the evaluated treatment was "beneficial" or "probably beneficial". Reported treatments included: glass ionomer cements (GIC), composite resin restorations, preformed metal crowns, laboratory fabricated crowns, microabrasion management of incisors and resin infiltration. **Conclusion:** Successful treatment options have been identified, such as GIC as a provisional restoration for severe cases and for uncooperative children; restorations with composite, indirect restorations, or preformed metal crowns also seem suitable treatment options for young patients diagnosed with MIH. There is still little evidence to support an approach for anterior teeth affected by MIH.

Keywords: Molar Hypomineralization; Dental Enamel Hypoplasia; Therapeutics; Molar.

Introduction

Molar incisor hypomineralization (MIH) is characterized by the presence of qualitative defects, such as discrete demarcated enamel lesions, affecting at least one permanent first molar with or without incisor involvement [1,2]. Various systemic, genetic and /or environmental factors have been associated with MIH, revealing a multifactorial etiological model [3]. Perinatal (hypoxia, caesarean section, and prematurity) and postnatal (measles, urinary tract infection, bronchitis, otitis media, gastric disorders, kidney diseases, pneumonia, and asthma) etiologic factors are considered to be more likely to increase the odds of MIH development compared to prenatal factors [3]. Clinically, hypomineralization is characterized by opacities of variable size that can change color from white to yellow/brown [4].

Teeth affected by MIH present wide variations according to their severity [5]. The mild form is associated with delimited opaque areas, varying from white to brown, especially in molars; this form generally does not present structural loss or major dental sensitivity [6]. The moderate form presents mild or null dental sensitivity, and the severe form mainly occurs at the level of the third occlusal/incisal, leading to post-eruptive degradation due to hardness reduction and high enamel porosity [6].

MIH affected teeth are often extremely sensitive to thermal and mechanical stimuli influencing children's quality of life by increasing their risk to develop caries, their susceptibility to breaking their teeth, failure of bonding to materials, as well as influencing on their behavior [5,7,8]. In addition, treatment may be more painful due to difficulties in applying local analgesia (due to altered nerve potential) and chronic subclinical inflammation caused by enamel porosity [5].

The management of MIH is a challenge for pediatric dentists due to its clinical appearance and treatment needs, thus knowing more on different treatment options (e.g., composite resin restorations, glass ionomer cements, metal crowns, indirect laboratory-manufactured restorations, etch-bleach-seal technique, etc.) [9], and their effectiveness may help to improve clinical outcomes on these patients. Especially, considering factors such as the cooperation of the patient, the stage of dental development, the severity of the defect, and parental preferences, among others [10].

The objective of this review is to identify the available evidence on the different treatment types for the rehabilitation of teeth affected with MIH in pediatric patients.

Material and Methods

This review was conducted according to the Joanna Briggs Institute's Reviewers Manual for JBI Scoping Reviews [11]. The protocol of this study is registered at OSF (https://osf.io/6yjbn/).

Eligibility Criteria

The inclusion criteria for this scoping review were observational studies (cohort, cross-sectional, clinical case, case series), systematic reviews, and randomized clinical trials; studies focused on caries treatment in hypomineralized molars or incisors in children between 6 and 16 years of age; articles published in English, Spanish and Portuguese. Studies on temporary teeth and other types of tooth enamel defects were excluded.

Search Strategy

A systematic search was performed in the following electronic databases: Pubmed, Cochrane Library, Epistemonikos and Lilacs using keywords and controlled terminology (MESH). We also searched in Google Scholar as part of the grey literature. We searched for articles published up to January 2022.

Study Selection

Two reviewers (DMT, OJC) independently selected research articles by title and abstract after duplicates were removed. Disagreements were solved by discussion between the two reviewers or by consulting a third reviewer when needed (CMG). The full-text version of relevant articles was retrieved and independently selected by the two reviewers according to the inclusion criteria. The selection process was carried out using the Rayyan online software.

Table 1. Full search strategy.

Databases	Keywords
PubMed/Medline	(((((child*[MeSH Terms]) OR (child*[Title/Abstract])) OR (pediatric patient [MeSH Terms])) OR (pediatric patient [Title/Abstract])) AND ((((hypomineralization, molar incisor[MeSH Terms]) OR (molar incisor hypomineralization[MeSH Terms])) OR (molar incisor hypomineralization[Title/Abstract])) OR (mih[Title/Abstract]))) AND ((treatment[MeSH Terms]) OR (treatment[Title/Abstract]))
Epistemonikos	title:((title:((title:((title:((title:((title:(molar incisor hypomineralization) OR abstract:(molar incisor hypomineralization))) OR abstract:((title:(molar incisor hypomineralization) OR abstract:(molar incisor hypomineralization))))) OR abstract:((title:((title:(molar incisor hypomineralization) OR abstract:(molar incisor hypomineralization))) OR abstract:((title:(molar incisor hypomineralization) OR abstract:(molar incisor hypomineralization)))))) OR (title:((title:(mih) OR abstract:(mih))) OR abstract:((title:(mih) OR abstract:(mih))))) OR abstract:((title:((title:((title:(molar incisor hypomineralization) OR abstract:(molar incisor hypomineralization))) OR abstract:((title:(molar incisor hypomineralization) OR abstract:(molar incisor hypomineralization))))) OR abstract:((title:((title:(molar incisor hypomineralization) OR abstract:(molar incisor hypomineralization))) OR abstract:((title:(molar incisor hypomineralization) OR abstract:(molar incisor hypomineralization)))))) OR (title:((title:(mih) OR abstract:(mih))) OR abstract:((title:(mih) OR abstract:(mih))))))) AND (title:((title:((title:(child*) OR abstract:(child*))) OR abstract:((title:(child*) OR abstract:(child*)))) OR (title:((title:(pediatric patient) OR abstract:(pediatric patient))) OR abstract:((title:(pediatric patient) OR abstract:(pediatric patient))))) OR abstract:((title:((title:(child*) OR abstract:(child*))) OR abstract:((title:(child*) OR abstract:(child*)))) OR (title:((title:(pediatric patient) OR abstract:(pediatric patient))
Cochrane	((Child)[Mesh] OR (child*) OR (pediatric patient)) AND ((Molar incisor hypomineralization) OR (mih)) AND((Therapeutics)[Mesh] OR (Treatment)
Lilacs	tw:((tw:(hipomineralización de los dientes)) AND (tw:(hipoplasia del esmalte dentario)) AND (tw:(niños)))
Google Scholar	"Molar incisor hypomineralization" AND "children" AND "treatment" AND "restorative"

Data Extraction

Two reviewers (DMT, OJC) independently extracted data on an Excel spreadsheet, including: author, year of publication, country of origin of the study, study design, objective of the article, MIH concept, sample size, sample age, main results and conclusions.

Results

We screened 1593 studies from the systematic search after duplicates were removed. One thousand sixty-five articles were excluded by title and abstract and 144 articles were screened by full-text. In total, 38 articles were included in this scoping review (Figure 1).

The main characteristics of the included studies are displayed in Table 2. These studies were published between 2010 and 2022, and most of them come from Europe [10,12-27] and Brazil [5,28-38]. In terms of the included studies' design, 20 were case reports [8,13,15,16,19,25-27,31,33-35,38-44], 7 were cohort studies [14,18,20,21,23,28,36]; 7 were randomized controlled trials [5,17,24,29,32,45,46] and 4 were systematic reviews [10,12,22,37]. The age range of the included sample was between 6 and 16 years old.

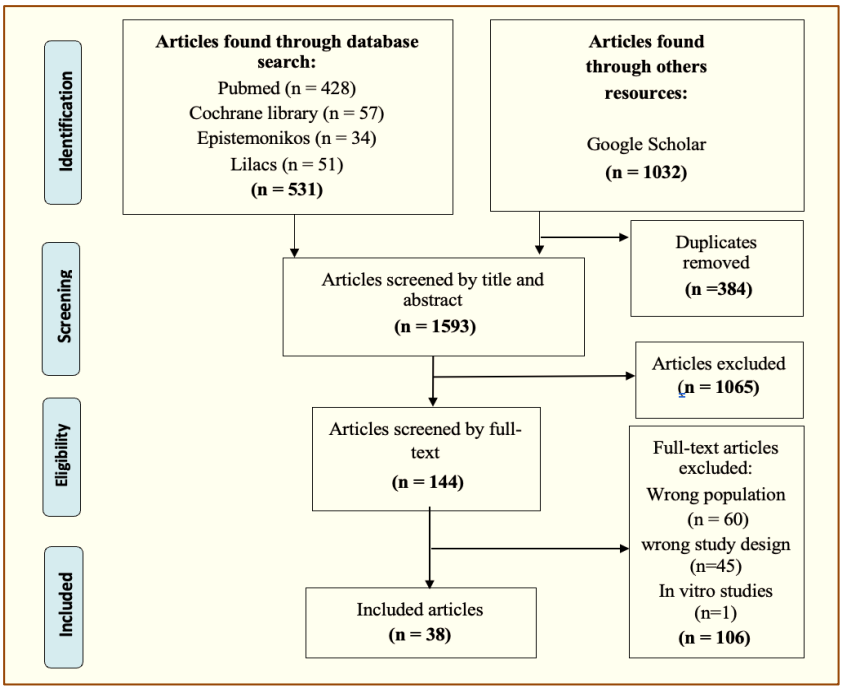

Figure 1. PRISMA flowchart describing the study selection process.

Most authors of the 38 included studies define MIH as a qualitative defect of the dental enamel, which causes disintegration of the occlusal surfaces and cusps [13,14,16,18,19,22,24,26,28,31-34,36,45]. Several studies also mentioned that MIH is characterized by creamy white, yellow or brown opacities affecting one or the first four permanent molars frequently associated with the permanent incisors. In addition, this condition is mainly considered to be of systemic etiology, attributed to the interrupted ameloblastic activity that occurs during the pre-eruptive maturational stages of amelogenesis [31,46]. However, a study carried out by Harika et al. [40] added that enamel defects in MIH may be also caused by local, genetic or environmental factors or even due to multiple factors, while other studies agreed that MIH is the result of the synergistic action of environmental factors and genetic expression, especially, genetic polymorphisms that begin prenatally and persists throughout childhood [5,40].

In addition, we mapped the scope of evidence using a bubble plot (Figure 2). Each bubble on the chart represents an included study. The graph shows information about the authors' conclusions in the X axis ("unclear", "no effect", "probably harmful", "harmful", "probably beneficial" and "beneficial") (Table 3), while the Y axis represents the study type, and the bubble size represents the number of teeth involved in the studies.

Out of the 38 included studies, 12 studies assessed glass ionomer cement and eight concluded that this material is "beneficial" [8,13,28,29,31,33,41,42], three studies concluded that it is "probably beneficial"[14,23,30], and one study concluded that its effects are “unclear” [26]. In terms of composite resin restorations, nine studies concluded that it is “beneficial” [18,19,21,24,27,34,38,40,44], one described it as “probably beneficial” [35], and two concluded that this material had “no effect” [5,32]. Additionally, four studies evaluating indirect restorations and full coverage crowns concluded that this treatment is “beneficial” [16,39,45,46]; four studies assessing stainless steel crowns also concluded that this treatment is “beneficial” [15,17,36,43]; while two studies that evaluated microabrasion, whitening and infiltration of resin concluded as that these are “probably beneficial” [20,25]. Three systematic reviews evaluated the different restorative materials in MIH, concluding these treatments as “probably beneficial” [10,12] and “unclear” [37]; one SR study evaluated the bond strength of the composite to the MIH affected enamel and concluded as “no effect” [22].

Table 2. Characteristics (author, type of study, country, age range and objectives) of included studies.

Author	Study Design			Country	Sample Age	Rehabilitation Treatment for MIH	Etiology			Type of Teeth Affected		
	RCT	Cohort	Case Report SR				Systemic	Multifactorial	Unknown	Incisor	molars	Incisor/ molars
Arce_Izaguirre et al. [41]			X	Peru	7 years	To evaluate the use of fluid giomers in a posterior tooth with loss of structure diagnosed with MIH.		X				X
Assunção et al.[35]			X	Brazil	7 years	To evaluate the longevity of restorative treatment through the use of composite resin in incisors and molars with MIH.			X			X
Bagattoni et al. [13]			X	Italy	6 years	To evaluate a conservative and provisional treatment through the use of an orthodontic band with cementation of glass ionomer cement.	X					X
Davidovich et al. [39]			X	Israel	8 years	To evaluate the treatment for children with MIH using a digital workflow with IOS (intraoral scanner) and CAD-CAM (computer-aided design and computer-aided manufacturing).		X				X
Dhareula et al. [46]	X	—		India	8-13 years	To compare the performance of minimally invasive cast metal and indirect resin inlays for the rehabilitation of first permanent molars with severe MIH.		X	—			X
De Oliveira et al. [30]			X	Brazil	7 years	To clinically evaluate glass ionomer cement restorations within 6 years which were then replaced by composite resin due to wear and recurrent caries.	X					X
Durmus et al. [14]		X		Turkey	8 years	To evaluate the survival and clinical performance of high-viscosity glass ionomer after selective removal of carious tissue in molar incisor hypomineralization.	X					X
De Farias et al. [36]		X	—	Brazil	7-10 years	To evaluate the survival of restorations with stainless-steel crown or composite resin in first permanent molars affected by MIH for 24 months		X	—			X
De Hoyos et al. [44]			X	Mexico	8 years	To evaluate the adhesive alternatives and their wide usefulness in this enamel defect as well as the correct use of adhesive agents.			—			
Fragelli [28]		X		Brazil	6-9 years	To evaluate the clinical performance of glass ionomer restorations in teeth with MIH.	X					X
Fernandez et al. [15]			X	Spain	9 years	To evaluate the effectiveness of the use of glass ionomer cement and the placement of metallic coronas in cases of severe MIH.			X		X	
Feierabend et al. [16]			X	Germany	6-15 years	To evaluate una rehabilitation in combination with no or minimally invasive preparation and pleasing esthetics in severely compromised teeth.		X				X
Futterer et al. [17]	X			Germany	8.5 years	To demonstrate the effects of different therapeutic strategies for teeth with MIH.		X				X
Gatón-Hernandez et al. [18]		X		Spain	6-8 years	To evaluate treatment efficacy using a minimally invasive approach in permanent molars with MIH.	X					X
Grossi, Cabral [29]	X			Brazil	7-13 years	To evaluate restorations' survival rate with hybrid glass restorative system using the atraumatic restorative treatment (ART) in first permanent molars with MIH.	X					X
Hahn et al. [19]			X	Germany	11 years	To evaluate the management of molar incisor hypomineralization from the mixed to the permanent dentition stage.		X				X
Hasmun et al. [20]		X		UK	7-16 years	To evaluate the quality of life through minimally invasive aesthetic treatment for masking the visibility of incisor opacities in children with MIH.	X					X
Harika et al. [40]			X	India	13 years	To evaluate the functional and aesthetic rehabilitation of a 13-year-old girl diagnosed with multiple developmental defects of enamel.		X				X

Kotsanos et al. [21]		X		Greece	7 years	To assess the treatment management of first permanent molars in children with MIH.	X				X
Lagarde et al. [22]			X	France	6-12 years	The objective of this study was to conduct a systematic review on bonding of adhesive materials to MIH-affected enamel, so as to identify all the suggested methods to optimize the bonding to this hypomineralized enamel and to determine which is (are) the best bonding protocol.	X				X
Linner et al. [23]		X		Germany	11 years	To evaluate survival rates using conventional non-invasive (GIC) and definitive treatment strategies (composite, CAD / CAM ceramic restorations).	X				X
Lygidakis et al. [24]	X			Greece	8-10 years	To evaluate the clinical performance of complex composite restoration placed on permanent molars with MIH.		X			X
Lygidakis [12]			X	Greece	6-16 years	To review the literature concerning the treatment of MIH, shortcomings and areas of future research.		X			X
Lopes-Fatturi [37]			X	Brazil	7-10 years	Evaluate the success of the restored treatment performed with different materials in molars with HIM.	X				X
Mejia-Herrera et al. [43]				X	Peru	8 years	To evaluate the possible rehabilitation options in cases of MIH through the use of preformed steel crowns and composite resin restorations			X		X
Mendonça et al. [33]				X	Brazil	11 years	To evaluate the adapted technique of simplified occlusal replication with conventional glass ionomer cement posterior teeth in a child with severe MIH.	X				X
Orellana et al. [8]				X	Chile	11 years	To evaluate the retention and resistance of the resin-modified glass ionomer and orthodontic band to occlusal forces with an 18-month follow-up in cases of severe MIH.		X		X	
Prud'homme et al. [25]				X	France	7-12 years	To evaluate the effectiveness of the etch-bleach-seal technique for the treatment of MIH opacities at the incisor level.	X				X
Pérez-Vasquez, Allende-Trejo [26]				X	Spain	9 years	To evaluate the effectiveness of using type 2 glass ionomer and ionomer-based fissure sealants in severe MIH.			X		X
Restrepo et al. [34]				X	Brazil	12 years	To evaluate a conservative and minimally invasive technique for the aesthetic management of MIH in anterior teeth with different degrees of severity, achieving favorable aesthetic results after one year of monitoring.	X				X
Romo [42]				X	Ecuador	8 years	To evaluate the pieces with MIH the same ones that were restored with glass ionomer cement and consider in a future possible restoration with inlays or coronas from 16 years of age.		X			X
Rolim et al. [32]	X				Brazil	7-16 years	To evaluate the survival of direct restorations on first permanent molars with MIH and the impact of treatment on self-reported dental pain.		X			X
Sabrosa et al. [38]				X	Brazil	11 years	To assess the clinical survival of the restoration of a permanent first molar with MIH using a preformed malleable composite resin crown.	X				X
Singh et al. [45]	X				India	8-15 years	To evaluate and compare the clinical performance of full coverage crowns on first permanent molars affected with MIH.	X				X
de Souza et al. [5]	X				Brazil	6-8 years	To evaluate the clinical survival of direct composite resin restorations in teeth with MIH compared with two adhesive systems (self-etching and total etching).					X
Somani et al. [10]			X		UK	6-10 years	Systematically evaluate the success of treatment modalities for molars and incisors affected by MIH.					X
Takahashi et al. [31]				X	Brazil	7 years	To evaluate restorations with different types of glass ionomer in teeth with MIH.	X			X	
Temudo et al. [27]				X	Portugal	9 years	To evaluate restorations in situations such as hypersensitivity and esthetics in MIH.	X				X

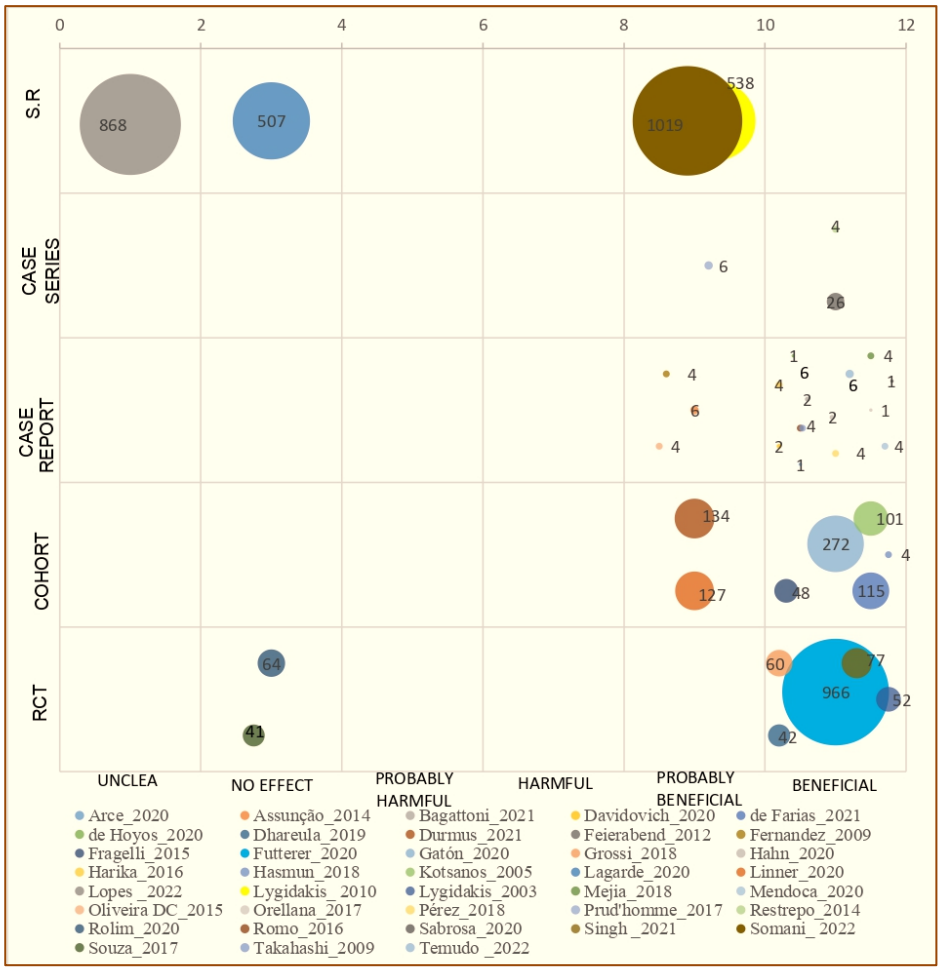

Figure 2. Bubble plot of the included evidence showing the study design, its sample size and the study's conclusion.

Table 3. Classification of studies' conclusions.

Beneficial	The study conclusions claim a beneficial effect without major adverse effects and without major concerns regarding the supporting evidence.
Probably Beneficial	The study conclusions do not report strong benefits despite the positive effect of the treatment.
Harmful	The study conclusions clearly indicate a harmful effect.
Probably Harmful	The study conclusions do not report a strong harmful effect despite the negative effect of the treatment.
No Effect	The study conclusions report that there is no difference between intervention and comparator.
Unclear	The study conclusions do not report one direction of the results due to conflicting results and limitations among individual studies.

In total, seven studies were RCT with a total of 1302 MIH teeth; there were seven Cohort studies that included 811 dental pieces; there were 20 case reports with 90 MIH teeth, and finally, four were two RS with a total of 2 932 MIH teeth.

Discussion

This scoping review included 38 studies published up to June 2022, which assessed different treatment options to restore MIH-affected teeth. According to the European Academy of Pediatric Dentistry (EAPD) and to experts who frequently deal with children presenting MIH, treatment decisions depend on the severity of the condition, dental age of the patient, expectations of both parents and children and the social origin of the

parent/child [47]. It has been recently highlighted that the defects' severity and the patient's age [9] are two main factors to be considered when treating children with MIH. In general, MIH causes aesthetics and hypersensitivity problems due to enamel rupture after teeth eruption, favoring the progression of caries leading to pulp involvement [4,48-50].

Based on the results obtained from the included studies, glass ionomer cement (GIC) can be used when moisture control is difficult, when the patient lacks cooperation, and in the early stages of the eruption, but its use should be limited in areas that support stress [9,47]. The use of GIC is helpful to increase patients' cooperation until they are mature enough for subsequent invasive and long-lasting treatments [23]. Fragelli et al. [28] showed that the probability to maintain the integrity of the dental structure in molars affected by MIH and restored with GIC is high, reporting a success rate of 78% at 12 months using a non-invasive approach. On the contrary, Linner et al. [23] showed lower survival rates of only 7% [23]. However, restorations' success and longevity could be influenced by the type of GIC, such as hybrid glass restorations, which result in a 98.3% success rate after 12 months of follow-up [29], or through the use of high-viscosity GIC, which has a success rate of 87.5% [14]. Additionally, Orellana et al. [8] suggested the use of resin-modified glass ionomer, which does not cause any symptom for at least 18 months, while Arce-Izaguirre et al. [41] recommends the use of fluid giomers, a new technology that combines previously reacted GIC and composite resin to obtain both of their properties, resulting in a more economical and resistant material compared to conventional ionomers.

In terms of composite resin restorations, several authors [18,19,21,24,27,34,35,40] use composite resin restorations as a predictable option, with high success rates, if placed under a rubber dam to ensure good moisture control [9]. This minimally invasive approach has been proposed for severe cases of MIH followed by cavity filling with GIC for six months and then restoration with composite resin, achieving a high clinical and radiographic success rate of 96.8% at 24 months [18]. However, Lygidakis et al. suggest a total removal of the hypomineralized enamel for a successful restoration, especially to achieve an optimal sealing, considering that the remaining enamel adhesion affected by MIH is poorer due to a reduced bond strength [9,19,21,24,44]. In addition, composite restorations seem to be the most suitable material since they adhere to the enamel without the need for retentive preparations [51]. When using total etching (with 37% phosphoric acid) and self-etch (without prior etching), no significant differences in survival rates of resin restorations have been found [5,32].

Laboratory-fabricated full-coverage restorations (zirconium crowns, lithium disilicate, and CAD-CAM-fabricated restorations) have recently been used to restore severely affected teeth by removing all decayed and hypomineralized enamel with clinical, long-lasting success after treatment with 24 months long evaluation; longer follow-up is required to reach a definitive conclusion [39,45]. However, available evidence suggests that laboratory-made restorations could be considered a more effective and long-term option, especially in older children when multiple surfaces or cusps are involved [9,10]; but drawbacks such as the extraction of more dental tissue, the difficulty of repair and higher costs must be considered when making the decision on using this technique [10]. Additionally, stainless steel crowns have been shown to be an alternative approach for severely affected molars, with a has a higher 24-month survival rate, but with other implications such as an increased overbite [10,15,16 36].

Treatment options for incisors affected by MIH have also been discussed in the included papers. According to Lygidakis et al. [9], a minimally invasive approach is important in children due to the large pulp chambers, high pulp horns and immature gums, including the preservation of tooth structure for future restorations [9]. The use of bleaching (10% carbamide peroxide) and remineralization to decrease enamel

opacities can increase the retention and durability of composite restorations bonded to hypomineralized enamel; however, more long-term studies are needed to find out whether there can be negative implications for this treatment type [40]. The etch-bleach-seal technique is a minimally invasive approach that can be used to remove yellowish-brown stains at the incisor level with MIH [9]. However, aesthetic gain is not guaranteed due to the deeper location of the defect [25].

Overall, included studies were mainly case report studies, which concluded that the evaluated treatment was "beneficial" or "probably beneficial", such as the case of glass ionomer cement, or composite resin restorations (as long as there is a complete removal of hypomineralized tissue to increase the longevity of the restorations). Indirect restorations manufactured in the laboratory were mainly classified as "beneficial" as they can be used when there are multiple affected surfaces and they have been associated with high survival rates. In addition, preformed metal crowns have been described as an alternative method for severely affected molars since they can maintain teeth's structural integrity. However, this result is only supported by four studies included in this review, which additionally describe a decrease in sensitivity as a side-effect [15,17,36,43].

The main strength of our scoping review is that we performed an exhaustive systematic search on several databases to bring all available evidence on clinical studies about the different treatment options that exist for children with MIH. Thus, we provided a full overview of studies on this subject that have been developed over the last two decades, including a diverse young population from different countries, continents and age ranges. However, a limitation we came across in this scoping review is that most included studies have a short follow-up period and small samples, which bring no clear conclusions on the benefit of the different treatment options. Another limitation of this study is that we only included studies published in English, Spanish and Portuguese, which might lead to a reporting bias since other studies on this subject could have been potentially published in other languages which have not been included.

Future studies should aim to develop more randomized clinical trials on the different treatment options and the use of different materials for the management of teeth affected by MIH. To provide reliable conclusions, studies should include a larger sample size and consider a longer-term follow-up regarding the changes in materials' adhesion properties, restoration failures, and quality of life improvement.

Additionally, using the keywords described in the methods section, we identified seven ongoing randomized clinical trials (RCTs) on this topic on the World Health Organization's International Clinical Trials Registry Platform and on clinical trials.gov [52-56]. Furthermore, we identified five ongoing systematic reviews in the National Institute for Health Research's International Prospective Register of Systematic Reviews (PROSPERO) [57-60] about the treatment of patients affected by MIH. These results could provide, in the near future, relevant evidence about the clinical question raised in this study.

Conclusion

There are different options for the rehabilitation of teeth affected by MIH; however, most evidence comes from case report studies and few clinical trials despite the high demand for research. Successful treatment options have been identified, such as the use of glass ionomer as a provisional restoration for severe cases and for uncooperative children; restorations with composite, indirect restorations, or preformed metal crowns seem suitable treatment options for young patients who have been diagnosed with MIH. There is little evidence to support any approach for anterior teeth previously affected by MIH.

Authors' Contributions

DMTY	https://orcid.org/0000-0002-7572-413X	Conceptualization, Methodology, Formal Analysis, Data Curation, Writing - Original Draft and Writing - Review and Editing.
OJC	https://orcid.org/0000-0001-9632-7320	Data Curation.
CMG	https://orcid.org/0000-0001-6763-3644	Conceptualization, Methodology, Formal Analysis, Writing - Original Draft and Writing - Review and Editing.

All authors declare that they contributed to critical review of intellectual content and approval of the final version to be published.

Financial Support

None.

Conflict of Interest

The authors declare no conflicts of interest.

Data Availability

The data used to support the findings of this study can be made available upon request to the corresponding author.

Acknowledgments

The authors of this study would like to thank to Dr. Inés Villacís for her support on the development of this scoping review and her contribution on the clinical views of this topic.

References

[1] Weerheijm KL, Jalevik B, Alaluusua S. Molar-incisor hypomineralisation. Caries Res 2001; 35(5):390. https://doi.org/10.1159/000047479

[2] Almuallem Z, Busuttil-Naudi A. Molar incisor hypomineralisation (MIH) - an overview. Br Dent J 2018; 225(7):601-9. https://doi.org/10.1038/sj.bdj.2018.814

[3] Garot E, Rouas P, Somani C, Taylor GD, Wong F, Lygidakis NA. An update of the aetiological factors involved in molar incisor hypomineralisation (MIH): a systematic review and meta-analysis. Eur Arch Paediatr Dent 2022; 23(1):23-38. https://doi.org/10.1007/s40368-021-00646-x

[4] Americano GC, Jacobsen PE, Soviero VM, Haubek D. A systematic review on the association between molar incisor hypomineralization and dental caries. Int J Paediatr Dent 2017; 27(1):11-21. https://doi.org/10.1111/ipd.12233

[5] de Souza JF, Fragelli CB, Jeremias F, Paschoal MAB, Santos-Pinto L, de Cássia Loiola Cordeiro R. Eighteen-month clinical performance of composite resin restorations with two different adhesive systems for molars affected by molar incisor hypomineralization. Clin Oral Investig 2017; 21(5):1725-33. https://doi.org/10.1007/s00784-016-1968-z

[6] Sundfeld D, da Silva LMS, Kluppel OJ, Santin GC, de Oliveira RCG, Pacheco RR, et al. Molar incisor hypomineralization: etiology, clinical aspects, and a restorative treatment case report. Oper Dent 2020; 45(4):343-51. https://doi.org/10.2341/19-138-T

[7] Rodd HD, Graham A, Tajmehr N, Timms L, Hasmun N. Molar incisor hypomineralisation: current knowledge and practice. Int Dent J 2021; 71(4):285-91. https://doi.org/10.1111/idj.12624

[8] Orellana C, Pérez V. Modified glass ionomer and orthodontic band: an interim alternative for the treatment of molar incisor hypomineralization: a case report. J Oral Res 2017; 6(3):70-4. https://doi.org/10.17126/%25x

[9] Lygidakis NA, Garot E, Somani C, Taylor GD, Rouas P, Wong FSL. Best clinical practice guidance for clinicians dealing with children presenting with molar-incisor-hypomineralisation (MIH): an updated European Academy of Paediatric Dentistry policy document. Eur Arch Paediatr Dent 2021; 23(1):3-21. https://doi.org/10.1007/s40368-021-00668-5

[10] Somani C, Taylor GD, Garot E, Rouas P, Lygidakis NA, Wong FSL. An update of treatment modalities in children and adolescents with teeth affected by molar incisor hypomineralisation (MIH): a systematic review. Eur Arch Paediatr Dent 2022; 23(1):39-64. https://doi.org/10.1007/s40368-021-00635-0

[11] Peters M, Godfrey C, McInerney P, Soares CB, Khalil H, Parker D. Methodology for JBI Scoping Reviews. In: Aromataris E. The Joanna Briggs Institute Reviewers Manual 2015. South Australia: Joanna Briggs Institute; 2015.

[12] Lygidakis NA. Treatment modalities in children with teeth affected by molar-incisor enamel hypomineralisation (MIH): A systematic review. Eur Arch Paediatr Dent 2010; 11(2):65-74. https://doi.org/10.1007/BF03262715

[13] Bagattoni S, Gozzi I, Lardani L, Piana G, Mazzoni A, Breschi L, et al. Case report of a novel interim approach to prevent early posteruptive enamel breakdown of molar-incisor hypomineralization–affected molars. J Am Dent Assoc 2021; 152(7):560-6. https://doi.org/10.1016/j.adaj.2021.04.015

[14] Durmus B, Sezer B, Tugcu N, Caliskan C, Bekiroglu N, Kargul B. Two-year survival of high-viscosity glass ionomer in children with molar incisor hypomineralization. Med Princ Pract 2021; 30(1):73-9. https://doi.org/10.1159/000508676

[15] Fernández CC, Rodríguez AL, Martínez SS, Dalmau LJB. Hipomineralización incisivo-molar (MIH). A propósito de un caso. Rev Odontológica Espec 2009; 4(2):1-5. [In Spanish].

[16] Feierabend S, Halbleib K, Klaiber B, Hellwig E. Laboratory-made composite resin restorations in children and adolescents with hypoplasia or hypomineralization of teeth. Quintessence Int 2012; 43(4):305-11.

[17] Fütterer J, Ebel M, Bekes K, Klode C, Hirsch C. Influence of customized therapy for molar incisor hypomineralization on children's oral hygiene and quality of life. Clin Exp Dent Res 2020; 6(1):33-43. https://doi.org/10.1002/cre2.245

[18] Gatón-Hernandéz P, Serrano CR, da Silva LAB, de Castañeda ER, da Silva RAB, Pucinelli CM, et al. Minimally interventive restorative care of teeth with molar incisor hypomineralization and open apex-A 24-month longitudinal study. Int J Paediatr Dent 2020; 30(1):4-10. https://doi.org/10.1159/000508676

[19] Hahn B, Krastl G, Halbleib K, Soliman S. Management of a patient with hypomineralized teeth from the mixed to permanent dentition stage - a case report with 6-year follow-up. J Adhes Dent 2020; 22(5):455-63. https://doi.org/10.3290/j.jad.a45176

[20] Hasmun N, Lawson J, Vettore MV, Elcock C, Zaitoun H, Rodd H. Change in oral health-related quality of life following minimally invasive aesthetic treatment for children with molar incisor hypomineralisation: a prospective study. Dent J 2018; 6(4):61. https://doi.org/10.3390/dj6040061

[21] Kotsanos N, Kaklamanos EG, Arapostathis K. Treatment management of first permanent molars in children with Molar-Incisor Hypomineralisation. Eur J Paediatr Dent 2005; 6(4):179-84.

[22] Lagarde M, Vennat E, Attal JP, Dursun E. Strategies to optimize bonding of adhesive materials to molar-incisor hypomineralization-affected enamel: a systematic review. Int J Paediatr Dent 2020; 30(4):405-20. https://doi.org/10.1111/ipd.12621

[23] Linner T, Khazaei Y, Bücher K, Pfisterer J, Hickel R, Kühnisch J. Comparison of four different treatment strategies in teeth with molar-incisor hypomineralization-related enamel breakdown - a retrospective cohort study. Int J Paediatr Dent 2020; 30(5):597-606. https://doi.org/10.1111/ipd.12636

[24] Lygidakis NA, Chaliasou A, Siounas G. Evaluation of composite restorations in hypomineralised permanent molars: a four year clinical study. Eur J Paediatr Dent 2003; 4(3):143-8.

[25] Prud'homme T, Hyon I, Dajean Trutaud S, Lopez Cazaux S. Different applicabilities of the etch-bleach-seal technique for treating opacities on permanent incisor damage by molar incisor hypomineralisation in three young patients. BMJ Case Rep 2017; 29:1-5. https://doi.org/10.1136/bcr-2017-221442

[26] Pérez-Vázquez AG, Allende-Trejo LE. Hipomineralización molar-incisivo, abordaje clínico. Caso clínico. Casos y Revis Salud 2018; 1(0):20-5. [In Spanish].

[27] Temudo R, Neves P, Ventura I, Lopes L. A conservative approach to rehabilitate a molar-incisor hypomineralization case. RGO 2022; 70(70). https://doi.org/10.1590/1981-86372022001020200140

[28] Fragelli CMB. Molar incisor hypomineralization (MIH): conservative treatment management to restore affected teeth. Braz Oral Res 2015; 29(1):1-7. https://doi.org/10.1590/1807-3107BOR-2015.vol29.0076

[29] Grossi J de A, Cabral RN. Glass hybrid restorations as an alternative for restoring hypomineralized molars in the ART model. BMC Oral Health 2018; 18(1):65. https://doi.org/10.1186/s12903-018-0528-0

[30] de Oliveira DC, Favretto CO, Cunha RF. Molar incisor hypomineralization: considerations about treatment in a controlled longitudinal case. J Indian Soc Pedod Prev Dent 2015; 33(2):152-5. https://doi.org/10.4103/0970-4388.155133

[31] Takahashi K, Correia A de SC, Cunha RF. Molar incisor hypomineralization. J Clin Pediatr Dent 2009; 33(3):193-7. https://doi.org/10.17796/jcpd.33.3.c0202140n373rg42

[32] Rolim TZC, da Costa TRF, Wambier LM, Chibinski AC, Wambier DS, da Silva Assuncao LR, et al. Adhesive restoration of molars affected by molar incisor hypomineralization: a randomized clinical trial. Clin Oral Investig 2020; 25(3):1513-24. https://doi.org/10.1007/s00784-020-03459-2

[33] Mendonça FL, Di Leone CCL, Grizzo IC, Cruvinel T, de Oliveira TM, Navarro MF de L, et al. Simplified occlusal replica adapted technique with glass ionomer cement for molar-incisor hypomineralization-affected molars: An 18-month follow-up. J Am Dent Assoc 2020; 151(9):678-83. https://doi.org/10.1016/j.adaj.2020.06.017

[34] Restrepo M, Fragelli C, Bussarteli DG, Feltrin J, Jeremias F, Cordeiro RCL, et al. Minimally invasive treatment for esthetic management of Molar-Incisor Hypomineralization (MIH) - a case report. CES Odontol 2014; 27(2):122-30.

[35] Assunção CM, Girelli V, Sarti CS, Ferreira ES, Araujo FB de, Rodrigues J de A. Hipomineralização de molar-incisivo (HMI): relato de caso e acompanhamento de tratamento restaurador. Rev da Assoc Paul Cir Dent 2014; 68(4):346-50. [In Portuguese].

[36] de Farias AL, Rojas-Gualdrón DF, Mejía JD, Bussaneli DG, Santos-Pinto L, Restrepo M. Survival of stainless steel crowns and composite resin restorations in molars affected by Molar-Incisor Hypomineralization (MIH). Int J Paediatr Dent 2021; 32(2):240-50. https://doi.org/10.1111/ipd.12849

[37] Lopes-Fatturi A, Wambier L, Rolim TZC, Reis A, de Souza JF. Restorative techniques for permanent first molars affected by hypomineralization: a systematic review. Pediatr Dent 2022; 44(1):17-24.

[38] Sabrosa CE, Geber K, Chagas B. The use of a preformed composite resin crown to treat molar incisor hypomineralization: a clinical report. Int J Res Reports Dent 2020; 3(2):8-13.
[39] Davidovich E, Dagon S, Tamari I, Etinger M, Mijiritsky E. An innovative treatment approach using digital workflow and cad-cam part 2: the restoration of molar incisor hypomineralization in children. Int J Environ Res Public Health 2020; 17(5):1-11. https://doi.org/10.3390/ijerph17051499
[40] Harika R, Dutta B, Arun P, Teja RP. A novel clinical approach for long-term retention and durability of resin restorations bonded to multiple developmental defects of enamel. J Int Soc Prev Community Dent 2016; 6(6):597-601. https://doi.org/10.4103/2231-0762.195507
[41] Arce-Izaguirre M, Torres-Ramos G, Alvino-Vales M, Barzola-Loayza M. Giómeros fluidos en la eliminación de sensibilidad en molar permanente afectada con Hipomineralización Incisivo Molar (HIM). Reporte de caso. Int J Interdiscip Dent 2020; 13(2):95-8. https://doi.org/10.4067/S2452-55882020000200095 [In Spanish].
[42] Romo A. Manejo estomatológico de la hipomineralización incisivo molar. Reporte de caso. Odontol Act Rev Científica 2016; 1(3):35-40. https://doi.org/10.31984/oactiva.v1i3.208 [In Spanish].
[43] Mejia-Herrera Z, Torres-Ramos G, Huamani-Huayhua L. Rehabilitación oral de hipomineralización incisivo molar. Rev Odontol Pediátrica 2018; 17(2):74-84. [In Spanish].
[44] de Hoyos AIG, Villarreal OR, Martell CPR. Restauracion directa con resina compuesta en hipomineralizacion molar incisiva, presentacion de caso clinico con seis meses de seguimiento. Rev AMOP 2020; 32(2):69-74. [In Spanish].
[45] Singh SK, Goyal A, Gauba K, Bhandari S, Kaur S. Full coverage crowns for rehabilitation of MIH affected molars: 24 month randomized clinical trial. Eur Arch Paediatr Dent 2021; 12(10):1-12. https://doi.org/10.1007/s40368-021-00657-8
[46] Dhareula A, Goyal A, Gauba K, Bhatia SK, Kapur A, Bhandari S. A clinical and radiographic investigation comparing the efficacy of cast metal and indirect resin onlays in rehabilitation of permanent first molars affected with severe molar incisor hypomineralisation (MIH): a 36-month randomised controlled clinical tri. Eur Arch Paediatr Dent 2019; 20(5):489-500. https://doi.org/10.1007/s40368-019-00430-y
[47] Lygidakis NA, Wong F, Jälevik B, Vierrou A-M, Alaluusua S, Espelid I. Best Clinical Practice Guidance for clinicians dealing with children presenting with Molar-Incisor-Hypomineralisation (MIH): An EAPD Policy Document. Eur Arch Paediatr Dent 2010; 11(2):75-81. https://doi.org/10.1007/BF03262716
[48] Jälevik B, Klingberg GA. Dental treatment, dental fear and behaviour management problems in children with severe enamel hypomineralization of their permanent first molars. Int J Paediatr Dent 2002; 12(1):24-32. https://doi.org/10.1046/j.0960-7439.2001.00318.x
[49] Bandeira Lopes L, Machado V, Botelho J, Haubek D. Molar-incisor hypomineralization: an umbrella review. Acta Odontol Scand 2021; 79(5):359-69. https://doi.org/10.1080/00016357.2020.1863461
[50] Elhennawy K, Rajjoub O, Reissmann DR, Doueiri M-S, Hamad R, Sierwald I, et al. The association between molar incisor hypomineralization and oral health-related quality of life: a cross-sectional study. Clin Oral Investig 2022; 26(5):4071-7. https://doi.org/10.1007/s00784-022-04375-3
[51] Elhennawy K, Schwendicke F. Managing molar-incisor hypomineralization: a Systematic Review. J Dent 2016; 55:6-24. https://doi.org/10.1016/j.jdent.2016.09.012
[52] Mohamed M. Restoration Quality in Molars Affected by Molar Incisor Hypo Mineralization. 2020. [Internet]. Available from: https://clinicaltrials.gov/ct2/show/NCT04475419 [Accessed on June 20, 2022].
[53] Mohie HM. A Comparison of Two Different Management Techniques for Extensive Molar Defects in Patients Suffering From Molar Incisor Hypomineralization (MIH) (Randomized Clinical Trial). 2020. [Internet]. Available from: linicaltrials.gov/ct2/show/study/NCT04209920 [Accessed on June 20, 2022].
[54] Marques FV. Three Restorative Protocols in MIH: a Randomized Controlled Clinical Study. 2021. [Internet]. Available from: https://clinicaltrials.gov/ct2/show/study/NCT03760497 [Accessed on June 20, 2022].
[55] Marty M. Computer-aided Design/Computer-aided Manufacturing for Mild to Moderate Molar Incisor Hypomineralization Treatment MIhCFAO. 2021. [Internet]. Available from: https://clinicaltrials.gov/ct2/show/NCT04922177 [Accessed on June 20, 2022].
[56] Mohamed N. Restoration of Permanent Molars Affected With (MIH) Using Composite Restorations or Preformed Metal Crowns. 2020. [Internet]. Available from: https://clinicaltrials.gov/show/NCT04658602 [Accessed on June 20, 2022].
[57] Lobo W, Sayed A, Sapkale K, Ramugade M. A Systematic Review on the comparative evaluation of esthetic durability of resin infiltration for treating white spot lesions and non carious enamel defects over remineralization, microabrasion or no intervention. PROSPERO 2021 CRD42021252941. [Internet]. Available from: https://www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42021252941 [Accessed on June 20, 2022].
[58] Schwendicke F, Elhennawy K. Managing molar-incisor hypomineralization: a systematic review. PROSPERO 2016 CRD42016039677. [Internet]. Available from: https://www.crd.york.ac.uk/prospero/display_record.php?RecordID=39677 [Accessed on June 20, 2022].
[59] Blanchet I, Camoin A, Tardieu C, Jacquot B. Microabrasion in the management of enamel white spots in paediatric dentistry: a systematic review. PROSPERO 2021 CRD42021282023. [Internet]. Available from: https://www.crd.york.ac.uk/prospero/display_record.php?RecordID=282023 [Accessed on June 20, 2022].

[60] de Souza JF, Wambier L, Wambier D, Chibinski AC, Lopes-Fatturi A, Cardoso T. Restorative approaches for molars affected by molar-incisor hypomineralization (MIH): a systematic review. PROSPERO 2017 CRD42017078336. [Internet]. Available from: https://www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42017078336 [Accessed on June 20, 2022].