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Therapeutic Approaches to Molar-Incisor Hypomineralization: An Integrative Review

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***Abstract*—** *Molar Incisor Hypomineralization (MIH) is a systemic disease that affects one to four permanent first molars, often associated with affected incisors. The treatments for this pathology vary according to the degree and location, and can be aimed at prevention, repair, and even extirpation of the dental element. This study aims to describe the therapeutic approach for people with Molar-Incisor Hypomineralization. Based on an integrative literature review, this study discusses therapeutic approaches in patients with MIH. The period from 2016 to 2022 was taken as a reference. Using the descriptors: "Molar-Incisor Hypomineralization"; "Dental Enamel"; "; "Pediatric Dentistry"; "Treatment" in the listed databases, 77 articles were identified. After applying the inclusion and exclusion criteria, nine articles were selected for this review. There are many recommended clinical therapies in recent literature including laser therapies alone or associated with other modalities with resin infiltration seem to be effective in treating dentin hypersensitivity. However, until now, there is no homogeneity in the existing protocols.*

I. INTRODUCTION

During the development of the dental enamel, it might occur disturbs called Defects in Enamel Development (DED) that cause defects in translucency and/or enamel color (Bezamat et al., 2021). These impacts on enamel development are critical since this tissue doesn't have the capacity for cellular repair (Lacruz et al., 2017; Smith et al., 2017;Alves et al., 2021).

There are 2 groups: quantitative defects, such as enamel hypoplasia, and qualitative defects, such as enamel hypomineralization (Folayan et al., 2018). Among these last developmental changes, the Molar-Incisor Hypomineralization (MIH) stands out, in which only after the year 2001, when received this name at the Congress of the European Academy of Pediatric Dentistry (EAPD), in Bergen.(Farias et al., 2018).

MIHHMIH is a systemic disease that affects one to four permanent first molars, often associated with affected

incisors (Shrestha; Upadhaya; Bajracharya, 2014; Kirthiga et al., 2015; Yannam et al., 2016). It's also called hypomineralized First Permanent Molars(FPM), idiopathic enamel hypomineralization, non-fluoridated hypomineralization, and demineralized FPM. Koch et al. called them cheese molars after conducting the first epidemiological study on permanent teeth of Swedish children (Krishnan; Ramesh, 2014).

The teeth affected by this lesion has lower mechanical properties, such as reduced elastic modulus, when compared with healthy enamel. This is because, molecularly, they have a large number of proteins, which inhibit the growth of hydroxyapatite crystals during enamel maturation (Bezamat et al., 2021; Alves et al., 2021).

The macrostructural characteristics of enamel increase the risk of rapid progression of caries disease, which can lead to tooth loss at very early ages. The frequency of restorative interventions and the need for retreatment are significantly higher when compared to groups of patients who do not have this pathology, so early diagnosis is essential to avoid further consequences. (Lopez Jordi et al., 2014).

The wide range of prevalence rates may be due to differences in population age, testing patterns, chosen index, or calibration. In two recent meta-analyses, the average global prevalence of MIH was estimated at 13.1% (Schwendicke et al., 2018) with significant differences between regions and countries and 14.2% (Dave; Taylor, 2018) with no significant difference. between boys and girls. Densely populated countries significantly contribute to high prevalence, while growing countries rank first in terms of prevalence (Schwendicke et al., 2018).

In Brazil, studies were made in the Southern, Northeast, and Midwest regions. In Southern, four studies reported rates of prevalence of 12.3%; 19.8%; 20.4%; and, 40.2%. The values found for the Northeast and Center-West regions were 18.4% and 14.69%, respectively. This variation is partly explained by the use of non-standardized methods of diagnosis and sample selection (LEITE, 2020).

Regarding treatment and the therapeutic decision, the choice depends on: the disease, the patient's age, cooperative capacity, socioeconomic status, the orthodontic importance of the affected tooth, the presence of other minor anomalies, and the patient's expectation (Ochoa et al. 2017).

The treatments proposed for teeth with MIH vary and go according to the degree and location, and can be aimed at prevention, repair, and even extirpation of the dental element. Fluorides, varnishes, and topical fluoride use, for example, are widely used in the management of sensitivity and prevention of dental caries, due to the fragility of the enamel, as in the aesthetic and functional treatment, the most used materials are composite resins and Glass Ionomer Cement (GIC). At the appropriate time, restoration with composites is considered a more feasible alternative to promote longevity (Domingos et al., 2019). This study aims to describe the therapeutic approach for people with Molar-Incisor Hypomineralization.

II. METHODOLOGY

This study is an integrative review of the literature on therapeutic approaches in patients with Molar-Incisor Hypomineralization (MIH). The period from 2016 to 2022 was taken as a reference.

Data collection was carried out in the Virtual Health Library (VHL) in Portuguese called by ''Biblioteca Virtual de Saúde'' (BVS) (https://bvsalud.org/) and PubMed (https://pubmed.ncbi.nlm.nih.gov/) databases in June 2022. The aim of the research was " What is the therapeutic approach in patients affected by Molar-Incisor Hypomineralization?".

Six steps were taken to design the review: 1) identification of the theme, 2) selection of the aim of the research; 3) establishment of inclusion and exclusion criteria for studies; 4) categorization of studies; 5) evaluation of studies; 6) interpretation of results and synthesis of knowledge.

The descriptors used for the selection of articles in Portuguese in the BVS were: "Hipomineralização Molar-Incisivo, EsmalteDentário, Odontopediatria, Tratamento", linked together by the Boolean operator "AND" and grouped to ensure greater specificity to the research. The descriptors used in English in the BVS comprised the following: "Molar-Incisor Hypomineralization"; "Dental enamel"; "Pediatric Dentistry"; "Treatment" also linked together by the Boolean operator "AND". For the selection of articles in PUBMED we used the descriptors related to each other by the Boolean operator "AND", which were: "Molar-Incisor Hypomineralization"; "Dental enamel"; "Pediatric Dentistry"; "Treatment".

The formulation of the central question of the integrative review used the PVO technique, where P refers to the Problem situation, participants or context; V comprises the study Variables, and O applies to the Outcome or expected result. Using the BVS technique the study population was defined as "Children with Molar-Incisive Hypomineralization", the variable of interest was "Molar-Incisive Hypomineralization" and the outcome/Outcome "Treatment".

Studies available in the BVS and PubMed databases that dealt with MIH and its therapeutic management in English and Portuguese from 2016 to 2022 were included.

The exclusion criteria were studies by year of publication and careful reading of abstracts; duplicate articles; laboratory studies; and those without full text available, articles outside the period from 2016 to 2022, as well as articles in languages other than Portuguese and English.

The survey of the main publications related to the therapeutic management of MIH was tabulated in a text editor. The subjects with titles of the publications and their respective authors are represented in table 1, in the results section.

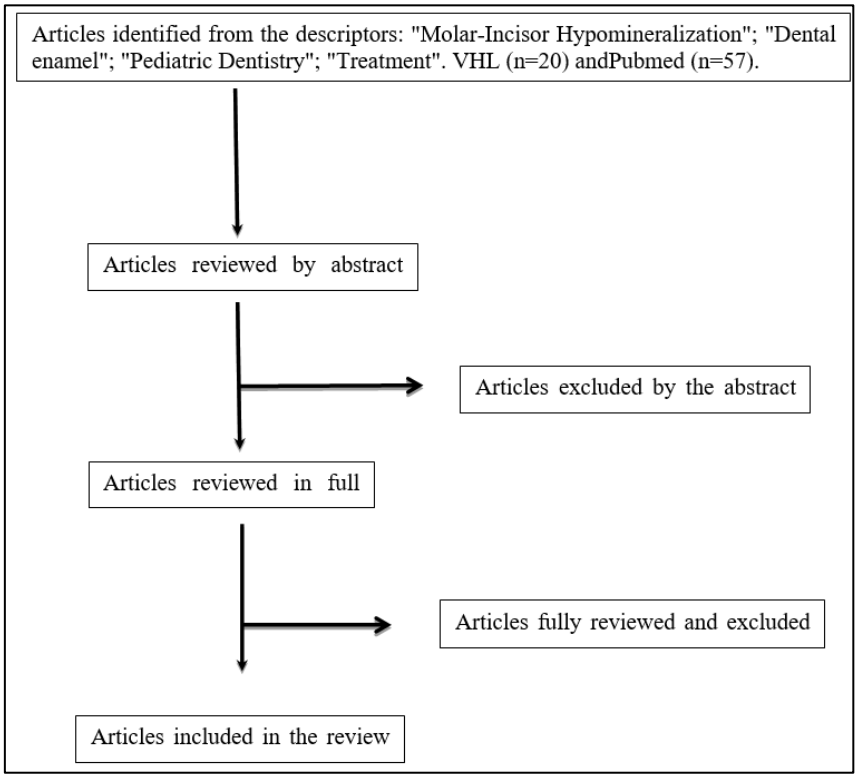

Fig.1 - Diagram of the study selection process

Source: Authors

III. RESULTS AND DISCUSSION

Using the descriptors: "Molar-Incisor Hypomineralization"; "Dental enamel"; "Dental enamel"; "Pediatric Dentistry"; "Treatment" in the listed databases, 77 articles were identified. After applying the inclusion and exclusion criteria, nine articles were selected for this review (Figure 1).

Chart 1 details the articles included in the review, according to criteria of authorship, publication period, type of study, objectives, and results.

Author/Year	Journal	Type of study	Objectives	Results
Bekeset al., 2021	Clin Oral Investig	Prospective multicenter study	To investigate the changes in QVRSO before and at different times after treatment of hypersensitive molars affected by MIH using the CPQ questionnaire.	Sealing hypersensitive molars affected by MIH with a composite material or a glass ionomer cement revealed a significant improvement in QVRSO immediately and over 12 weeks of follow-up.
Durmuset al., 2021	Clínica MedPrinc	Prospectiveint erventionstudy	To evaluate the clinical survival of a high-viscosity glass ionomer (HVGI) at 2-year	Restoration using HVGI after SCR was observed to be an effective approach to maintain

			follow-up to restore molar incisors severely affected by hypomineralization post selective removal of decayed tissue (SCR).	the integrity of the tooth structure.
Vieira et al., 2019	Medicine (Baltimore)	Controlledclinicaltrial	To evaluate the clinical effect of antimicrobial photodynamic therapy (aPDT) on permanent teeth with severe MIH and painful sensitivity, associated with the presence of caries lesion.	In situations of deep lesions associated with MIH (mainly with risk of pulpal exposure) selective soft dentin removal should be applied, i.e. removal of this soft tissue only from the surrounding walls, keeping the soft dentin from the pulpal wall
Somaniet al., 2022	EurArchPaediatrDent	Systematicreview	Systematically review the success of treatment modalities for molars and incisors affected by MIH.	Resin-based fissure sealants, preformed metal crowns, direct and indirect composite resin restorations for molars affected by MIH in specific clinical settings.
Weber et al., 2021	Reserchandscience	Systematicreview	Systematically search the literature for treatment options (i.e. preparation and pretreatment of the substance tooth as well as the choice of material) to restore teeth affected by different severities of MIH.	Resin-modified glass ionomer cements appear to be superior to conventional glass ionomer cements; resin composites are expected to be suitable for restoring all severities of MIH and indirect restorations (i.e. onlays or partial crowns) show a good long-term clinical success, but should be restricted mainly to severe cases of MIH.
Muñozet al., 2020	BMC Oral Health.	Cross-sectionalstudy	To evaluate and compare the perceptions, knowledge and clinical experiences of MIH in general dentists (GDPs) and pediatric dentists (PDs) in Spain.	They use GICs more often, taking advantage of their remineralizing potential, except in incisors, where they use composites.
Lygidakiset al., 2022	EurArchPaediatrDent.	Updated policy paper from the European Academy of Pediatric Dentistry	Evaluate etiological factors involved in MIH and treatment options for clinical management.	Despite an increase in the number of studies addressing the management of teeth affected by MIH, evidence is still limited, with conventional restorative options being the most common approach.
Farias et al., 2018	Journal of Medical and Biological Sciences	Integrativereview	To review the literature on MIH in order to provide the dental surgeon who treats children with information about the diagnosis, clinical features, and treatment.	Tooth whitening, deep infill technique, sealant application, use of desensitizing pastes, restorations with GIC, resin and use of steel crowns.

Dullaet al., 2021	SwissDent J	Narrativerevie w	The purpose of this review is to summarize current knowledge on the etiology, prevalence and diagnosis of IMH, as well as to provide guidance on treatment decision as well as to discuss evidence for non- and micro-invasive interventions.	Use of glass ionomer cement as intermediate coverage, but mainly composite resins are materials of choice, use of steel crown.

Source: Authors

The study by Bekes et al. (2021), showed that sealing hypersensitive molars affected by MIH with composite resin or a GIC revealed significant improvement immediately and over 12 weeks of follow-up, showing that treating hypersensitive molars with a sealing technique leads to positive changes in the child's quality of life. According to Fragelli et al. (2017) the application of resin sealants can be useful in the treatment of mild MIH to prevent the progression of carious lesions.

Schraverus et al. (2021), showed that molars that were not sealed were 77% more likely to develop dental caries lesions compared to molars that received a Glass Ionomer Sealant application. This protective effect is due to the sealant acts as a mechanical barrier, physically isolating the pits and fissures from the oral environment. In addition, one of the main advantages of GIC is the release of fluoride, which is associated with the prevention of caries. Another positive feature offered is the reduction of hypersensitivity, allowing better oral hygiene for the patient and therefore contributing to the prevention of caries (Alves et al., 2021).

Vieira et al. (2019) state that when teeth are already affected by caries lesions, treatment should respect the principles of minimal intervention. The removal of infected dentin from the surrounding walls only should be performed, keeping this tissue in the pulp wall. Immediately after this selective removal, antimicrobial photodynamic therapy is performed, using the PapacárieMblue gel, modified with the addition of methylene blue as a photosensitizer for desensitization and decontamination in conjunction with the low-power laser.

Rolin et al. (2021) reported the challenge of adhesion to hypomineralized enamel, being difficult in performing direct restorations because hypomineralized enamel has less mineral content, high protein content, and lower resistance related to microhardness with masticatory forces. Previous studies recommend the total removal of hypomineralized enamel until a solid enamel is obtained, improving the bond strength of restorative materials to the tooth surface.

Durmus et al (2020) stated that restoration using high viscosity glass ionomer (HVGI) after selective removal of carious tissue (SCR) was observed as an effective approach to maintain the integrity of tooth structure. Teeth severely affected by MIH are more susceptible to restoration failure and repeated treatments (Jalevic, Klingberg, 2002; Kotsanos et al., 2005). The benefits of SCR-HVGI in clinical practice (especially in public dental clinics) are its simplicity, shorter operation time, and better treatment of behavioral problems in MIH compared to conventional caries removal (Franzon et al., 2014; Maltz et al., 2013).

A systematic review by Somani et al. (2022) states that fissure sealants are predominantly used for fully erupted molars that have mild MIH. In this review, only three studies were included with a low total number of sealants placed (184). One of them did not report which material was used (Kotsanos et al.2005a,b), while all three studies used different primary outcome measures. A significant difference in retention rate was observed in one study when an adhesive was applied before the placement of a resin-based fissure sealant (Lygidakiset al.2009). This has been reported in teeth not affected by MIH (McCafferty; O'Connell, 2016).

Studies advise that amalgam restorations on teeth affected by MIH should be avoided due to the lack of adhesion and need for physical retention, which in conjunction with atypically shaped cavities can further increase margin breakage (Ghanim et al., 2017). Furthermore, a European directive (Article 10 (2) of the Mercury Regulation (EU) 2017/852) has advised against the use of amalgam in children under 15 years of age unless strictly necessary which is likely to lead to a decline in its use in research and clinical practice.

In contrast, eight studies in this systematic review used direct composite resin restorations in 793 molars, most of which were severely affected by MIH. Overall, the

reported success rates suggest that this is an effective option for the management of molars affected by MIH, where the rupture or carious lesions do not extend to the pulp or do not present with irreversible pulpitis, even in the most severe cases. Total or partial removal of hypomineralized enamel before restoration with composite resin under rubber dam isolation remains a reliable technique in terms of restoration success rates.

Lab-made indirect restorations may be considered a better option in the long term, especially in older children; however, the included studies followed participants for no more than 43 months, highlighting the need for longer studies. (Zagdwon et al., 2003; Gaardmand et al., 2013; Dhareula et al., 2019)

An alternative approach for severely affected molars is to use Preformed Metal Crowns (PMC). Although only three studies included in this review using PMC for molars affected by MIH, they outperformed all other restorative materials with one study reporting 86% success rate (Oh et al., 2020) and others reporting a 100% success rate (Kotsanos et al,2005a,b; Koleventi et al., 2018).

In a systematic review by Weber et al (2021) the mechanical properties of resin-modified glass ionomer cement are superior to those of conventional glass ionomer cements. When indirectly comparing the 12-month success rates of conventional glass ionomer cement with that of resin-modified glass ionomer cements, a clinical study investigating a resin-modified glass ionomer cement showed a success rate of 98.3% (Grossi et al., 2018), whereas a clinical study investigating a conventional glass ionomer cement showed a survival rate of 78.7% (Fragelli et al., 2015). However, it should be noted that the two studies were designed and conducted differently concerning the severity of hypomineralization and pretreatment of the teeth.

Studies investigating composite resins for the restoration of teeth affected by MIH suggest that these materials can be used to restore all severities of MIH. (Lygidakis et al., 2009; de Souza et al., 2017; Fragelli et al., 2017; Sonmez&Saat 2017; Gatón-Hernandéz et al. 2020; Linner et al., 2020; Rolim et al., 2021). However, the use of composite resins requires good patient compliance during treatment, at best with rubber dam application. Regarding the preparation of the tooth substance, a higher survival rate of composites has been demonstrated after the complete removal of the MIH-affected enamel (Sönmez&Saat 2017; Linner et al., 2020).

In the study by Munõz et al., (2020) As for the material of choice in cases of post-eruptive fractures, resin-modified glass ionomer (RMGIC) was the most commonly used by both groups. However, there were significant differences in the use of glass ionomer cement (GIC) between PIBs (12.21%) and odontopediatricians (18.40%). No significant differences were found in the materials used to restore opacity, with RMGIC again being the first choice in both groups. However, in the case of treating incisor lesions, the composite resin was the material of choice in both groups, with significant differences in the use of RMGIC between general dentists and odontopediatricians.

Studies are showing that GIC (81%) was more used than resin-modified GIC (44.3%), which is justified by the higher fluoride release. (Crombie et al., 2008). However, a recent systematic review showed that the failure rate of restorative materials in the treatment of MIH is higher with the use of amalgam and glass ionomers, and the highest success rate is achieved with indirect restorations, preformed stainless steel crowns (SSC), and composite resin restoration (Elhennawy; Schwendicke, 2016). In other studies, the composite was the material of choice. (Gamboa et al., 2018; Alanzi et al., 2018; Silva et al., 2016; Crombie et al., 2008), and was recommended by Lygidakis et al., 2010, in moderate lesions.

Farias et al., (2018), The treatment of demarcated opacities can be performed by different conducts among which tooth whitening (Harika et al., 2016) and more recently the deep infiltration technique (Giannetti et al., 2018), aiming at aesthetic improvement (Giannetti et al., 2018; Harika et al., 2016). In hypomineralized molars, the direct application of sealants shows an adequate survival rate, suggesting that they can be used to prevent carious lesions (Fragelli et al., 2017).

The use of desensitizing materials is also reported in the literature. The study developed by Bekes et al., (2017) exposed that the use of desensitizing pastes containing 8% arginine and calcium carbonate associated with a brushing program with the toothpaste of the same composition with additional 1450 ppm fluoride and mouthwash for 8 weeks, demonstrated a reduction of hypersensitivity in molars affected by MIH. Positive sensitivity reduction results were reported immediately and after completion of the study (Bekes et al., 2017).

Some studies indicate the performance of temporary restorations with restorative Glass Ionomer Cement and its clinical and radiographic follow-up, for teeth affected by MIH and cavitated (Fragelli et al., 2015; Grossi et al., 2018; Oliveira; Favretto; Cunha, 2015; Orellana; Pérez, 2017). In the works of Grossi et al., (2018). Direct restorations have their indication the more conservative the preparation of the tooth (Souza et al., 2017). Already indirect restorations such as onlays and steel crowns, are indicated in teeth with large extensions of coronary destruction, in the last case it is advisable that exodontia is

indicated along with orthodontic treatment for rehabilitation of the functional arc (Mathu-Muju; Kennedy, 2016).

Dulla et al., (2021) stated that for treatment of MIH the application of a flowable Glass Ionomer Cement is recommended as an intermediate protection. To stabilize the porosity of the structures of hypomineralized molars, resin infiltration appears to prevent enamel breakage to a greater extent when compared to fluoride varnish (Nogueira et al., 2020). If hypersensitivity persists after the application of a sealant, a direct or indirect restoration should be chosen.

The extent of it will determine whether the tooth is restorable or not, and the treatment of a molar affected by MIH with post-eruptive enamel fracture but no hypersensitivity is determined by the location and size of the defect. If the loss of substance does not occur in the fissure and includes less than 1/3 of the tooth surface, a sealant is recommended. However, if there is a localized loss of substance in the fissure or the size of the defect is greater than 1/3 of the tooth or the defect is close to the pulp, then short-term temporary restoration using GIC with or without orthodontic banding should be the therapy of choice. After the tooth has matured, the temporary filling can be replaced with a permanent restoration. Alternatively, a long-term temporary restoration in the form of a steel crown may also be an option.

IV. CONCLUSION

There are many recommended clinical therapies in recent literature to reduce the difficulties caused by MIH, which are hypersensitivity, post-eruptive fractures, and adhesion difficulty. Laser therapies alone or associated with other modalities with resin infiltration seem to be effective in treating dentin hypersensitivity. Sealants seem to be an alternative to avoid fractures,also the development of dental caries lesions and finally, adhesive materials can be used, although physical and chemical alterations in dental tissues interfere in their efficacy and sometimes indirect restorations can be used with good clinical results. However, further studies are still needed to determine homogeneous and effective clinical protocols for the treatment of molar-incisor hypomineralization.

REFERENCES

[1] Alanzi A., Faridoun A., Kavvadia K., Ghanim A. (2018) Dentists' perception, knowledge, and clinical management of molar-incisor-hypomineralisation in Kuwait: a cross-sectional study. BMC Oral Health. 18:34.

[2] Alves, M.C.O; Camargos, B.S.F; Carvalho, T.A; Machado, F.C. (2021). Clinicalprotocols in Molar-Incisor Hypomineralization (MIH): anintegrativeliteraturereview Protocolos Clínicos enlaHipomineralización Molar-Incisivo (MIH): una revisión bibliográfica integrador. Research, Society and Development, v. 10, n. 13, 1-9. 9 http://dx.doi.org/10.33448/rsd-v10i13.21605

[3] Bekes, K. et al. (2017) Efficacy of desensitizing products containing 8% arginine and calcium carbonate for hypersensitivity relief in MIH-affected molars: an 8-week clinical study. Clin.Oral Investig., Berlin, v. 21, n. 7, p. 2311-2317, Sept.

[4] Bekes, K; Amend, S; Priller, J; Zamek, C; Tanja, S; Kramer, N. (2021). Changes in oral health-related quality of life after treatment of hypersensitive molar incisor hypomineralization–affected molars with a sealing. Clinical Oral Investigations, 25:6449–6454. https://doi.org/10.1007/s00784-021-03947-z

[5] Bezamat, M., Souza, J. F., Silva, F., Corrêa, E. G., Fatturi, A. L., Brancher, J. A., Carvalho, F. M., Cavallari, T., Bertolazo, L., Machado-Souza, C., Koruyucu, M., Bayram, M., Racic, A., Harrison, B. M., Sweat, Y. Y., Letra, A., Studen-Pavlovich, D., Seymen, F., Amendt, B., Werneck, R. I., … Vieira, A. R. (2021). Gene-environment interaction in molar-incisor hypomineralization.PloS one, 16(1), e0241898.https://doi.org/10.1371/journal.pone.0241898.

[6] Crombie FA, Manton DJ, Weerheijm KL, Kilpatrick NM (2008) Molar incisor hypomineralization: a survey of members of the Australian and New Zealand Society of Paediatric Dentistry. Aust Dent J.53:160–6

[7] Dave M, Taylor G. Global prevalence of molar incisor hypomineralisa?tion. Evid Based Dent. 2018;19(3):78–9. https://doi.org/10.1038/ sj.ebd.6401324.

[8] De Souza J F, Fragelli C B, Jeremias F, Paschoal M A B, Santos-Pinto L, de Cassia LoiolaCordeiro R (2017) Eighteen-month clinical performance of composite resin restorations with two different adhesive systems for molars affected by molar incisor hypomineralization. Clin Oral Investig 21: 1725–1733.

[9] Dhareula A, Goyal A, Gauba K, Bhatia S, Kapur A, Bhandari S. (2019) 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 randomized controlled clinical trial. EurArchPaediatrDent. 20; 489–500.

[10] Domingos PAS, Donato HAR, Nonato CN, Souza EO, Silva VJ. (2019) Molar Incisor Hypomineralization: literature review. Journal of Research in Dentistry. 7(1):8-12.

[11] Dulla J A, Meyer-Lueckel H; (2021) Molar-incisor hypomineralisation: narrative review on aetiology, epidemiology, diagnostics and treatment decicion. Swiss Dent J 131: 886–895

[12] Durmus, B; Sezer, B; Tugcu, N; Caliskan, C; Bekiroglu, N; Kargul, B. (2020). Two-Year Survival of High-Viscosity Glass Ionomer in Children with Molar Incisor

Hypomineralization. Med Princ Prac,;30:73–79, 10.1159/000508676.

[13] Elhennawy K, Schwendicke F. (2016) Managing molar-incisor hypomineralization: a systematic review. J Dent. 55:16–24 European Archives of Paediatric Dentistry. 23:39–64 https://doi.org/10.1007/s40368-021-00635-0

[14] Farias, L., Laureano, I. C. C., Alencar, C. R. B. de, & Cavalcanti, A. L. (2018). Hipomineralização molar-incisivo: etiologia, características clínicas e tratamento. Revista De Ciências Médicas E Biológicas, 17(2), 211–219. https://doi.org/10.9771/cmbio.v17i2.27435

[15] Folayan, M. O.,Chukwumah, N. M., Popoola, B. O., Temilola, D.O., Onyejaka, N.K., Oyedele, T.A., Lawal, F.B.(2018). Developmental defects of the enamel and its impact on the oral health quality of life of children resident in Southwest Nigeria. BMC Oral Health 18, 160.https://doi.org/10.1186/s12903-018-0622-3

[16] Fragelli C M B, Souza J F, Bussaneli D G, Jeremias F, Santos-Pinto L D, Cordeiro R C L (2017) Survival of sealants in molars affected by molar-incisor hypomineralization: 18-month follow-up. Braz Oral Res 31; 30

[17] Fragelli C M, Souza J F, Jeremias F, CordeiroRde C, Santos-Pinto L (2015) Molar incisor hypomineraliza?tion (MIH): conservative treatment management to restore affected teeth. Braz Oral Res 29: S1806-83242015000100271

[18] Fragelli C. M. B., Souza, J.F., Bussaneli, D.G., Jeremias, F., Santos-Pinto, L., Cordeiro, R.S.L. (2017) Survival of sealants in molars affected by molar- -incisor hypomineralization: 18-month follow-up.Braz. Oral Res., São Paulo, v. 31, n. 1, p. 1-9, Apr.

[19] Fragelli, C., Souza, J. F., Bussaneli, D. G., Jeremias, F., Santos-Pinto, L. D., & Cordeiro, R. (2017). Survival of sealants in molars affected by molar-incisor hypomineralization: 18-month follow-up. Brazilian oral research, 31, e30.https://doi.org/10.1590/1807-3107BOR-2017.vol31.0030

[20] Fragelli C.M., Sousa, J.F., Jeremias, F., Cordeiro, R.C.L., Santos-Pinto, L. (2015) Molar incisor hypomineralization (MIH): conservative treatment management to restore affected teeth.Braz. Oral Res., São Paulo, v. 29, n. 1, p. 1-7, June.

[21] Franzon R, Guimarães LF, Magalhães CE, Haas AN, Araujo FB. (2014) Outcomes of one-step incomplete and complete excavation in pri?mary teeth: a 24-month randomized con?trolled trial. Caries Res. 48; 376–383.

[22] Gaardmand E, Poulsen S, Haubek D. (2013) Pilot study of minimally invasive cast adhesive copings for early restoration of hypomineralisedfrst permanent molars with post-eruptive breakdown. Eur Arch Paediatr Dent. 14:35–39.

[23] Gamboa GCS, Lee GHM, Ekambaram M, Yiu CKY.(2018) Knowledge perceptions, and clinical experiences on molar incisor hypomineralization among dental care providers in Hong Kong. BMC Oral Health. 2018; 217-219

[24] Gatón-Hernandéz P, Serrano C R, da Silva L A B, de Castañeda E R, da Silva R A B, Pucinelli C M, Manton M, Ustrell-Torent J M, Nelson-Filho P (2020) Minimally interventive restorative care of teeth with molar incisor hypomineralization and open apex – A 24-month longitudinal study. Int J Paediatr Dent 30: 4–10

[25] Ghanim A, Silva MJ, Elfrink MEC, Lygidakis NA, Mariño RJ, Weerheijm KL, Manton DJ (2017) Molar. incisorhypomineralisation (MIH) training manual for clinical feld surveys and practice. Eur Arch Paediatr Dent. 18:225–242.

[26] GIANNETTI, L. et al. (2018) Deep infiltration for the treatment of hypominera?lized enamel lesions in a patient with molar incisor hypomineralization: a clinical case. J. Biol. Regul. Homeost.Agents., Milano, v. 32, n. 3, p. 751-754, May/June

[27] Grossi J A, Cabral R N, Ribeiro A P D, Leal S C (2018) Glass hybrid restorations as an alternative for restor?inghypomineralized molars in the ART model. BMC Oral Health 18: 65

[28] HARIKA, R. et al. (2016) 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., Mumbai, v. 6, n. 6, p. 597-601, Nov./Dec.

[29] Jälevik B, Klingberg GA. (2002) Dental treatment, dental fear and behaviour management problems in children with severe enamel hypomineralization of their permanent first molars. Int J Paediatr Dent. 12; 24– 32.

[30] Koch M J, García-Godoy F. (2000) The clinical performance of laboratory-fabricated crowns placed on first permanent molars with developmental defects. J Am Dent Assoc 131: 1285–1290.

[31] Koleventi A, Sakellari D, Arapostathis KN, Kotsanos N. (2018) periodontal impact of preformed metal crowns on permanent molars of children and adolescents: a pilot study. Pediatr Dent. 40; 117–121.

[32] Kotsanos N, Kaklamanos EG, Arapostathis K. (2005 a) Treatment management of frst permanent molars in children with Molar-Incisor Hypomineralisation.Eur Arch Paediatr Dent.4:179–184.

[33] Kotsanos N, Kaklamanos EG, Arapostathis K. (2005 b) Treatment management of frst permanent molars in children with Molar-Incisor Hypomineralisation.Eur J Paediatr Dent. 6; 179–184.

[34] Krishnan R, Ramesh M. (2014) Molar incisor hypomineralisation: A review of its current concepts and management. SRM J Res Dent Sci. 5:248-52.

[35] Lacruz, R. S., Habelitz, S., Wright, J. T., & Paine, M. L. (2017). Dental enamel formation and implications for oral health and disease. Physiological reviews, 97(3), 939–993. https://doi.org/10.1152/physrev.00030.2016

[36] Leite, L.C. Prevalence of Incisor Molar Hypomineralization in Bragantine children from 6 to 8 years old.(2020). 16 f. TCC (Graduation) - Dentistry Course, Universidade São Francisco, BragançaPaulista, 2020.

[37] Linner T, Khazaei Y, Bücher K, Pfisterer J, Hickel R, Kühnisch J (2020) Comparison of four different treat?ment strategies in teeth with molar-incisor hy?pomineralization-related enamel breakdown – A retrospective cohort study. Int J Paediatr Dent 30: 597–606

[38] López Jordi, M. D. C., Cortese, S. G., Álvarez, L., Salveraglio, I., Ortolani, A. M., & Biondi, A. M. (2014).Comparison of the prevalence of incisor molar hypomineralization in children with different health care coverage in the cities of Buenos Aires (Argentina) and Montevideo (Uruguay). SaúdeColetivaLanús, 10 (2), 243-251.

[39] Lygidakis NA, Dimou G, Stamataki E. (2009) Retention of fissure sealants using two different methods of application in teeth with hypomineralised molars (MIH): a 4-year clinical study. Eur Arch Paediatr Dent. 10; 223–226.

[40] Lygidakis NA, Wong F, Jälevik B, Vierrou A-M, Alaluusua S, Espelid I. (2010) Best clinical practice guidance for clinicians dealing with children presenting with molar-incisor-hypomineralisation (MIH): an EAPD policy document. Eur Arch Paediatr Dent; 11:75–81.

[41] Maltz, M., Jardim J.J., Mestrinho H.D., Yamaguti P.M., Podestá K., Moura M.S., Paula, L.M.(2013) Partial removal of carious dentine: a multicenter randomized controlled trial and 18-month follow-up results. Caries Res. 47; 103–109.

[42] Mathu-Muju, k. R.; Kennedy, D.B. (2016) Loss of permanent first molars in the mixed dentition: Circumstances resulting in extraction and requiring orthodontic management. Pediatr Dent., Chicago, v. 38, n. 5, p. 46-53, Oct.

[43] McCaferty J, O'Connell AC. (2016) A randomized clinical trial on the use of intermediate bonding on the retention of fissure sealants in children. Int J Pediatr Dent. 26:110–115.

[44] Muñoz, C.S; Beneyto, Y.M; Silva, A.P; Pascual, A.P; López, F.J.I; Ruiz, A.J.O. (2020). Perception, knowledge, and attitudes towards molar incisor hypomineralization among Spanish dentists: a cross-sectional study. BMC Oral Health. 20, 2-10. https://doi.org/10.1186/s12903-020-01249-6

[45] Nogueira, V.K.C., Mendes Soares, I.P., Fragelli, C.M.B., Boldieri, T., Manton, D.J., Bussaneli, D.G., Cordeiro, R.C.L. (2020) Structural integrity of MIH-affected teeth after treatment with fluoride varnish or resin infiltration: An 18-Month randomized clinical trial. J Dent 29: 105: 103570

[46] Ochoa, D.A., Contreras, I.R., Melendez, J.D., & Vidal, P.S. (2017). AbordajeTerapéutico de laHipomineralización Molar - Incisal. Revisión Narrativa. Internationaljournalofodontostomatology, 11, 247-251.DOI:10.4067/S0718-381X2017000300247

[47] Oh N, Nam S, Lee J, Kim H. (2020) Retrospective study on the survival rate of preformed metal crowns in permanent first molars. Journal of the Korean Academy of Pediatric Dentistry. 47; 140–147.

[48] Oliveira, D.C.; Favretto, C.O.; Cunha, R.F. (2015) Molar incisor hypomineralization: Considerations about treatment in a controlled longitudinal case. J. Indian Soc. Pedod. Prevl Dent., Chandigarh, v. 33, n. 2, p. 152- 155, Apr./June

[49] Orelanna, C.; Pérez, V. (2017) Modified glass ionomer and orthodontic band: an interim alternative for the treatment of molar incisor hypomineralization. A case report. J. Oral Res., Concepción, v. 6, n. 3, p. 70-74, Mar.

[50] Rolim, T., da Costa, T., Wambier, L. M., Chibinski, A. C., Wambier, D. S., da Silva Assunção, L. R., de Menezes, J.,& Feltrin-Souza, J. (2021). Adhesive restoration of molars affected by molar incisor hypomineralization: a randomized clinical trial. Clinical oral investigations, 25(3), 1513–1524. https://doi.org/10.1007/s00784-020-03459-2

[51] Schraverus, M. S., Olegário, I. C., Bonifácio, C. C., González, A., Pedroza, M., & Hesse, D. (2021). Glass Ionomer Sealants Can Prevent Dental Caries but Cannot Prevent Posteruptive Breakdown on Molars Affected by Molar Incisor Hypomineralization: One-Year Results of a Randomized Clinical Trial. Caries research, 55(4), 301–309. https://doi.org/10.1159/000516266

[52] Schwendicke F, Elhennawy K, Reda S, Bekes K, Manton DJ, Krois J. (2018) Global burden of molar incisor hypomineralization. J Dent. 68:10–8. https://doi.org/10.1016/j.jdent.2017.12.002.Erratum.In:JDent.2019Jan;80:89-92.

[53] Schwendicke, F., Elhennawy, K., Reda, S., Bekes, K., Manton, D. J., &Krois, J. (2018). Global burden of molar incisor hypomineralization.Journal of dentistry, 68, 10–18.https://doi.org/10.1016/j.jdent.2017.12.002

[54] Shrestha R, Upadhaya S, Bajracharya M.(2014) Prevalence of molar incisor hypomineralisation among school children in Kavre. Kathmandu Univ Med J (KUMJ. 12:38-42.

[55] Silva MJ, Alhowaish L, Ghanim A, Manton DJ.(2016) Knowledge and attitudes regarding molar incisor hypomineralisation amongst Saudi Arabian dental practitioners and dental students.Eur Arch Paediatr Dent. 17:215–22

[56] Smith, C.E.L., Poulter, J.A., Antanaviciute, A., Kirkham, J., Brookes, S.J., Inglehearn CF and Mighell AJ (2017) Amelogenesis Imperfecta; Genes, Proteins, and Pathways. Front. Physiol. 8:435. DOI: 10.3389/fphys.2017.00435.

[57] Somani, C; Taylor, G.D; Garot, E; Rouas, P; Lygidakis, N.A; Wong, F.S.L. (2022). An update of treatment modalities in children and adolescents with teeth affected by molar incisor hypomineralisation (MIH): a systematic review.

[58] Sönmez H, Saat S (2017) A Clinical Evaluation of Deproteinization and Different Cavity Designs on Resin Restoration Performance in MIH-Affected Molars: Two-Year Results. J ClinPediatr Dent 41: 336–342.

[59] Souza, J. F., Fragelli, C.B., Jeremias, F., Paschoal, M.A.B., Sousa-Pinto, L., Coderio, R.C.L. (2017) Eighteen-month clinical performance of composite resin restorations with two different adhesive systems for molars affected by molar incisor hypomineralization. Clin Oral Investig., Berlin, v. 21, n. 5, p. 1725-1733, June

[60] Vieira, L., Paschoal, M., de Barros Motta, P., Ferri, E. P., Ribeiro, C., Dos Santos-Pinto, L., Motta, L. J., Gonçalves,

M., Horliana, A., Fernandes, K., Ferrari, R., Deana, A. M., &Bussadori, S. K. (2019). Antimicrobial photodynamic therapy on teeth with molar incisor hypomineralization-controlled clinical trial.Medicine, 98(39), e17355.https://doi.org/10.1097/MD.0000000000017355

[61] Weber, K.R; Wierichs, R.J; Luckel, H.M; Flury, S. (2021). Restoration of teeth affected by molar-incisor hypomineralisationA systematic review. SWISS DENTAL JOURNAL SSO, 131, 988-997.

[62] Zagdwon AM, Fayle SA, Pollard MA. (2003) A prospective clinical trial comparing preformed metal