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MOLAR INCISOR HYPOMINERALIZATION (MIH)

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ABSTRACT

Dental enamel is the hard tissue that once formed it is not remodeled, unlike other hard tissues such as bone. Because of its non remodeling nature, alterations of enamel during its formation are permanently recorded on the tooth surface. One such developmental defect of the enamel is Molar Incisor Hypomineralization (MIH). MIH is the condition of demarcated enamel opacities of various sizes and color of systemic origin affecting one or more first permanent molars (FPMs), frequently associated with permanent incisors. The affected teeth could undergo post eruptive breakdown (PEB) under the influence of masticatory forces due to soft and porous enamel, that subsequently results in atypical cavities or even complete coronal disintegration. MIH is common, and as such it should be diagnosed and managed in primary care wherever possible. Early diagnosis can lead to more effective and conservative management. This article aims to give an overview of MIH, from its etiology to treatment options in young patients.

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INTRODUCTION

Molar Incisor Hypomineralization was defined in 2001 by Weerheijm *et al*. as hypomineralization of systemic origin of one to four permanent first molars, frequently associated with affected incisors.[1] MIH is considered a worldwide clinical problem with a global prevalence ranging from 2.8% to 40.2%.[2] This condition was known with multiple names, namely, cheese molars or idiopathic enamel hypomineralization or nonfluoride hypomineralization. It occurs due to a disturbance in one of the stages of amelogenesis thus leading to a qualitative defect.

Classification: Currently, several approaches exist to classify the severity of MIH.

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Mathu-Muju and Wright (2006)[3] classified MIH as

- ***Mild MIH*:** Demarcated opacities in nonstress-bearing area, isolated, no fracture, no hypersensitivity or caries.
- ***Moderate MIH*:** Intact atypical restorations, demarcated opacities on occlusal/incisal third of teeth without post-eruptive enamel breakdown (PEB), PEB or caries limited to 1 or 2 surfaces without cuspal involvement.
- ***Severe MIH*:** PEB, history of sensitivity, caries, crown destruction, defective atypical restoration, esthetic concerns.
- After encountering certain difficulties in differentiating between moderate and severe cases, Lygidakis *et al*. proposed a classification with mild and moderate-severe categories.

Lygidakis *et al*. (2008)[4] classified MIH as:

- Mild cases
- Severe cases

In mild cases, teeth show demarcated enamel opacities without enamel breakdown and occasional sensitivity to external stimuli but not to brushing and only mild aesthetic concerns on discoloration of the incisors.

In severe cases, demarcated enamel opacities with PEB, caries, persistent/spontaneous hypersensitivity affecting function and finally strong aesthetic concerns that may have socio-psychological impact are observed.

Etiology: It has been proposed that MIH is a consequence of disturbed ameloblast function in the later maturation phase of amelogenesis resulting in defective enamel with a significantly increased protein content. As MIH mainly involve molars and incisors, so the causative disturbance probably have occurred between the end of the second gestational trimester up to the age of 4 years. Etiology of MIH is still unclear. Various studies suggests the different etiological or systemic factors associated with MIH. These factors may be present during prenatal, perinatal and post natal period of development. The prenatal factors include various medical problems to the mother during pregnancy such as cardiologic diseases, infections of the urinary tract, A and D vitamin deficits, anemia, toxicity, diabetes mellitus and rubella embryopathy. The peri-natal factors include Cesarean section, complicated vaginal delivery, Preterm birth and respiratory distress/ hypoxia.[5,6,7] The post natal factors include childhood illnesss during first 4 years of life including asthma, adenoids, infections, tonsillitis, fever, acute otitis media, pneumonia, chickenpox, measles, antibiotic intake and low vitamine D serum concentration.[8,9,10,11]

Clinical features: Clinically, the lesions of MIH are fairly large demarcated opacities of altered enamel translucency. The defective enamel is white-cream or yellow-brown in color. The enamel of MIH molars is soft and porous and has the appearance of discoloured chalk or old Dutch cheese. The opacities are usually limited to the incisal or cuspal one third of the crown, rarely involving the cervical one third. The affected FPM (First Permanent molar) may undergo post-eruptive enamel breakdown because of occlusal loading, whereas incisors rarely exhibit post-eruptive enamel breakdown. The structural defect of enamel of the molars affected by MIH may lead to early caries involvement and rapid progression which may be hastened by the difficulty in brushing those acutely sensitive teeth. A well know problem for patients with permanent first molars diagnosed with MIH is hypersensitivity, causing severe subjective problems during eating or brushing teeth. The MIH-affected FPM's are sometimes hypersensitive to stimuli and may be difficult to anesthetize. Affected teeth can be very sensitive to a current of air, whether cold or warmth (even with enamel that has not disintegrated), and mechanical stimuli, for instance toothbrushing, may create toothache in these teeth. It is believed that there is subclinical pulpal inflammation due to porosity of the enamel which could lead to hypersensitivity experienced by some individuals. Following administration of local anesthetic, some MIH patients continue to experience pain on instrumentation. Caries progression is very rapid in FPM affected by MIH due to the porous enamel and the presence of caries can act to mask the true diagnosis of MIH.

Diagnostic criteria: A separate judgment criteria for MIH in epidemiological studies were developed in 2003. Weerheijm *et al*. proposed that an optimum age for checking the condition would be 8 years (as all four permanent molars and most permanent incisors should have erupted).[12] Teeth should be examined wet; however, if needed, then cotton rolls may be used to clean tooth surface to better visualize it.

Judgement criteria for MIH according to Weerheijm *et al*. (2003) (table 1)

Each tooth should be examined for

- Absence or presence of demarcated opacities
- (defect altering the translucency of the enamel)
- Posteruptive enamel breakdown (loss of surface enamel after tooth eruption, usually associated with a pre-existing opacity)
- Atypical restorations (frequently extended to the buccal or palatal smooth surfaces reflecting the distribution of hypoplastic enamel)
- Extracted molars due to MIH
- Failure of eruption of a molar or incisor

Table 1. Judgement criteria for MIH

Key feature	Description
Demarcated opacities	Clearly demarcated opacities Variability in color and size Defects less than 1 mm not to be reported
Post-eruptive enamel breakdown	Defect of the surface after eruption of the tooth Loss of enamel from an initially formed surface after tooth eruption Frequently associated with a pre-existing demarcated opacity
Atypical restorations	Size and shape of restorations not conforming to the temporary caries picture Frequently extends to the buccal and palatal/lingual surfaces Frequently associated with an opacity at the margin of the restoration For incisors, a buccal restoration can be noticed not related to trauma
Extraction of molars due to MIH	Absence of a first permanent molar should be related to the other teeth of the dentition Opacities or atypical restorations in the other first permanent molars combined with absence of a first permanent molar Absence of first permanent molars in an otherwise sound dentition in combination with demarcated opacities on the incisors
Failure of eruption of a molar or an incisor	First permanent molar or the incisor to be examined are not yet erupted

Molar Hypomineralization Severity Index (MHSI): (table 4): Molar Hypomineralization Severity index (MHSI) was given by Kelly Oliver *et al*. (2013)[15] and suggested that the MHSI characteristics were predictive of the treatment of the affected FPMs and can guide management. Children with dentitions with at least one affected FPM, all PIs (Permenant Incisors) erupted, and no affected PIs were diagnosed with molar hypomineralization (MH). Those with at least one affected FPM plus at least one affected PI were diagnosed with molar incisor hypomineralization (MIH). Children were diagnosed provisionally with molar hypomineralization* (MH*) if they had at least one affected FPM and no affected PIs, but at least one PI was unerupted. Those with only one or two erupted, affected FPMs were invited to enter later on eruption of other FPMs. Affected FPMs and PIs were examined according to EAPD criteria, recorded characteristics were as follows:eruption, colour, and location of most severe defect, number of restorations placed/replaced at the practice,

Criteria for determining molar–incisor hypomineralization (MIH) according to the European Academy of Pediatric Dentistry (EAPD).[13] (table 2)

Mark	Criterion
0	Enamel without defect
1	White/creamy limited areas of opacity without posteruptive loss of enamel
1a	White/creamy limited areas of opacity with posteruptive loss of enamel
2	Yellow/brown limited areas of opacity without posteruptive loss of enamel
2a	Yellow/brown limited areas of opacity with posteruptive loss of enamel
3	Atypical restorations
4	Tooth loss due to MIH
5	Partially erupted teeth (less than one-third of the dental crown) with the MIH present
6	Unerupted/partially erupted teeth without MIH
7	Diffuse opacity (not MIH)
8	Hypoplasia (not MIH)
9	Combined changes (diffuse opacity/hypoplasia with MIH)
10	Limited opacity areas only on incisors

atypical restorations, PEB, and child-reported sensitivity at initial visit (temperature, tooth brushing).

Table 3. EAPD criteria. Ghanim *et al*. (2015)[14] proposed A detailed diagnostic chart was proposed combining both clinical presentation of the enamel lesion and the size of the surface area affected: (table 3)

Mark	Criterion
0	no visible enamel defect
1	enamel defect, non-MIH
2	White creamy demarcated, yellow or brown demarcated opacities
3	PEB
4	Atypical restoration
5	Atypical caries
6	Missing because of MIH
7	Cannot be scored
Lesion extension criteria (after diagnosing i.e. scores 2 to 6):	
I	less than one third of the tooth affected
II	at least one third but less than two thirds of the tooth affected
II	at least two thirds of the tooth affected

Severity of MIH: The severity of hypomineralization can be recorded according to the Wetzel and Reckel scale.[16]

- **Degree 1 (mild):** Isolated white and cream to yellowish-brown discolorations on the chewing surface and upper part of the crown
- **Degree 2 (Moderate):** Hypomineralized yellowish-brown enamel affecting more or less all the humps on top of the crown but with only a slight loss of substance.
- **Degree 3 (severe):** Large-scale mineral deficiency with distinct yellowish-brown discolorations and defects in crown morphology resulting from extensive loss of enamel.

DIFFERENTIAL DIAGNOSIS: Molar incisor hypomineralization may be mistaken for a range of other conditions. Therefore, it is essential to distinguish between MIH and other abnormalities in the dental structures.

Amelogenesis Imperfecta (AI): The amelogenesis imperfecta can be differentiated from MIH, as there is generalized involvement of both primary and permanent dentitions and a common familial history is there in AI.

Table 4. Molar Hypomineralization Severity Index (MHSI)

Characteristics of molar hypomineralization defects	Severity of Characteristic	Weighting assigned
Eruption status	Unerupted	0
	Erupted	1
Location of most severe defect	None	0
	Smooth surface	1
	Occlusal surface (FPMs)	2
	Incisal edge (PIs)	2
	Cuspal involvement (FPMs)	3
Restorations placed/ replaced	None	0
	One	1
	Two or more	2
Atypical restorations	None	0
	0 Present	1
Post eruptive enamel breakdown (PEB)	None	0
	Present	1
Sensitive to temperature (child report)	None	0
	Sensitive	1
Sensitive to tooth brushing (child report)	None	0
	Sensitive	1

Enamel Hypoplasia: The margins of hypoplastic enamel lesions are mostly regular and smooth, whereas borders of MIH lesions are sharp and irregular due to post-eruptive shearing of weakened enamel.[17]

Fluorosis: Clinically fluorosis affected teeth show linear, patchy, or confluent white, yellow or brown opacities without a clear boundary in the enamel. In contrast, MIH does not show diffuse opacities but demarcated opacities.

White spot lesions: White spot lesions can be distinguished from MIH because they occur in vulnerable areas of plaque stagnation, such as the cervical or gingival margin of the tooth on an area where enamel hypomineralization rarely occurs.[17]

TREATMENT APPROACHES

Treatment options for teeth with MIH range from prevention, restoration to extraction. Based on the MIH-TNI (Molar Incisor Hypomineralization-Treatment Need Index) (fig. 1,2), a treatment plan for each index is developed as well ranging from prophylaxis, sealing, restoration (temporary or permanent) to extraction. Suitability of these treatment approaches, however, differs depending on the index with corresponding symptoms of MIH.

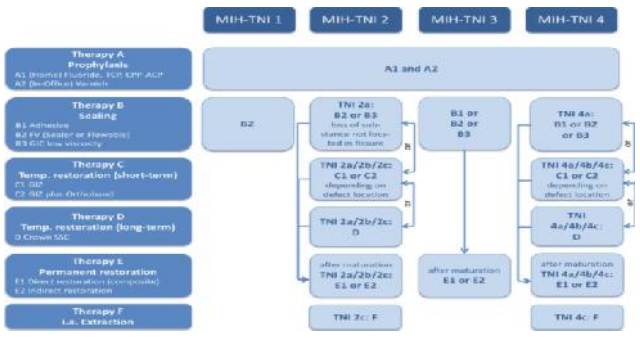

Fig. 1. MIH-TNI therapy plan based on the MIH-TNI in patients with low caries risk.[18]

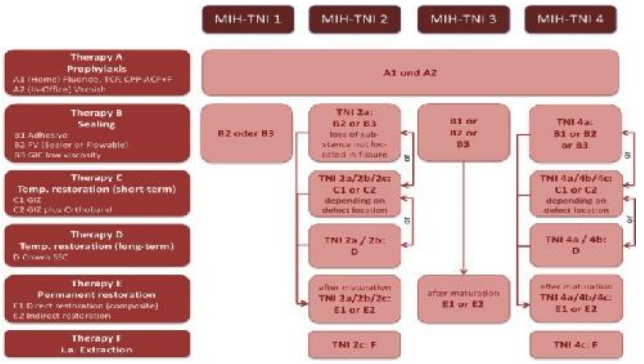

Fig.2. MIH-TNI therapy plan based on the MIH-TNI in patients with high caries risk[18]

Preventive Treatment Approaches: Preventive treatment approaches include use of fluoridated toothpaste, application of fissure sealants and fluoride varnishes/gels.

Direct Restorations of MIH-Affected Teeth: The choice of the materials depends on the defect severity, the age and cooperation of the child. Adhesive materials are chosen due atypical cavity outlines following removal of hypomineralized enamel.

For dentin replacement or as an interim restoration, GIC provides placement ease, fluoride release and chemical bonding. The resin modified GIC offer similar advantages and incorporation of resin and photoinitiators improves handling, wear resistance, fracture toughness and fracture resistance.

Indirect Restoration Approaches for MIH-Affected Teeth

For MIH molars with extensive defects, especially where there is significant cuspal involvement, preformed metal crowns often provide an expedient and effective medium interim solution.[19] Stainless steel crowns (SSCs) can preserve molars with MIH until cast restorations are feasible.[20] Furthermore, these crowns can be placed in molars with poor prognosis to preserve the MIH tooth at an early stage while waiting for the ideal extraction time.

Aesthetic Management of Molar Incisor Hypomineralization: Staged Strategies for Affected Incisors

- **Remineralization strategies:** The remineralization function of the active molecule, casein phosphopeptide-amorphous calcium phosphate (CPP-ACP) crème relative to the restoration of mineralization, morphology and porosity has been well-documented in the literature in its treatment of hypomineralized white spot lesions with calcium and phosphate levels recovering to almost that of normal, mature enamel.[21]
- **External vital bleaching:** For the chromatically affected lesion with significant background lesion contrast, there has been reported effectiveness in improving lesion appearance with the use of carbamide peroxide in custom nightguard or bleaching trays.
- **Resin infiltration:** Hypomineralized enamel lesions have increased porosity and therefore could be suitable for the resin infiltration method originally designed for carious lesions. This approach is microinvasive and one that requires two components:
- Firstly, chemomechanical treatment to remove the more highly mineralized surface layer to increase penetration of the infiltrant.
- Secondly, under desiccated conditions, a low viscosity resin may be infiltrated into the body of the lesion with both mechanical and active diffusion mechanisms.[22]

Extraction: When FPM are severely hypomineralized, restoration may be impossible and extraction must be considered. In such cases, early orthodontic assessment is recommended for the management of the developing occlusion.

CONCLUSION

Esthetics, phonectics and mastication are the basic functions of the dentition. Disruptions in any of these biological characteristics can affect not only the masticatory efficacy but also the emotional and social well being of the child. Molar Incisor Hypomineralization (MIH) is one such clinical condition, having multifactorial etiology. The prevalence of MIH appears to be increasing. The management of MIH depends on the diagnosis and severity of the condition. In mild MIH cases, application of remineralizing agents and restorations are recommended, whereas in cases of severe MIH,root canal treatment and stainless steel crowns are recommended. Lastly, making a correct and early diagnosis of MIH allows the clinician to better predict prognosis and to more accurately counsel patients.

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