

MOLAR INCISOR HYPOMINERALISATION: A REVIEW OF ETIOLOGY, DIAGNOSIS CRITERIA AND PATTERNS CONSIDERING EAPD CRITERIA

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Abstract

Introduction: MIH (Molar incisor hypo mineralisation) syndrome is a multifactorial pathology frequently encountered by paediatric dentists. The aim of the study was to identify the aetiology and the main criteria for diagnosis of MIH syndrome. **Material and Methods:** A review of the literature, relating to MIH, was undertaken using evidence obtained from the electronic databases and guidelines, published between 2016-2021. The items selected were: aetiology, classification, diagnosis of MIH. **Results:** MIH is a condition with multifactorial aetiology; genetic component with the influence of environmental factors acting in the prenatal, perinatal and postnatal period are the most important to consider. Main diagnostic criteria for MIH are enamel hypo mineralisation of the first permanent molars and permanent incisors, demarcated opacities, enamel breakdown, dental hypersensitivity and atypical coronary restorations. The presence of demarcated opacities at the level of temporary second molars could be a predictive factor for MIH syndrome. **Conclusions:** Given the multiple etiological factors, the increased prevalence of MIH syndrome, the variety of clinical features and the association with increased caries risk, it is necessary for dentists to consider early and effective diagnosis using simple diagnostic criteria.

Keywords: MIH, aetiology, classification, diagnosis.

Introduction

The prevalence of MIH (Molar incisor hypo mineralisation) syndrome is constantly increasing, becoming a pathology frequently encountered by paediatric dentists.

The aetiology is still uncertain, certainly multifactorial. This pathology was encountered more frequently in prematurely born children and in those who had systemic health problems during the first 3 years of life [1].

Several genes are as well considered as factors for the onset of MIH syndrome [2].

MIH is the consequence of a disturbance of ameloblast function during amelogenesis which will cause defects in the enamel structure. These can be classified as mild, moderate or severe defects depending on whether or not the dentin is exposed [3]. In patients affected by MIH, the main clinical manifestation is the appearance of enamel defects on the occlusal and vestibular surface of the permanent first molars and on the vestibular surface of the permanent incisors. Teeth that have hypo mineralisation lesions have also hypersensitivity, leading to poor oral hygiene and being more prone to cavities [4, 5]. The objectives of the study were to report and analyse the opinion of specialists on the diagnostic criteria for MIH syndrome and to identify the main etiological factors that influence MIH occurrence, considering EAPD (European Academy of Paediatric Dentistry) criteria.

Material and Methods

A review of the literature was conducted between May and June 2021, using information obtained from the electronic databases: PubMed, Scopus, Web of Science, Google Scholar and EAPD (European Academy of Paediatric Dentistry) guidelines. The medical terms (MeSH) that were searched separately and cross-referenced were: incisor molar hypo mineralisation, aetiology, clinical types, classification, diagnosis, differential diagnosis or similar variants. A search filter was set up to select publications: ("molar incisor hypo mineralisation"[mh] OR "molar incisor hypo

mineralisation"[tiab] OR "molar incisor hypo mineralization"[mh] OR "molar incisor hypo mineralization"[tiab]) AND (aetiology OR aetiology OR clinical types OR classification OR diagnosis OR differential diagnosis OR mechanisms)" and the time period between 2016-2021 was considered.

According to the selection criteria 310 articles were found. We included all types of clinical studies (retrospective or prospective, controlled trials or cohort studies) presenting the main etiological factors elements of clinical positive and differential diagnosis of MIH. The articles must be published in English, and the entire article text must be available. Subsequently, 40 articles were elected from the resulting list.

Selection process: three authors (AM, CIM, AM) screened titles independently and compared their findings. Study selection was assessed independently by two authors (AM and CIM), who performed the assessment of titles and/or abstracts of retrieved studies. In cases of disagreement, studies were included after consensus was reached through discussion between the 2 mentioned authors and a third author (MJ).

Results

Aetiology

MIH is a condition with multifactorial aetiology; it is determined by several genes and influenced by environmental factors and therefore occurs in various clinical forms. The varieties of MIH, with a single molar involvement, are explained by the different expression of genes between the right and left side (Table 1).

Table 1. MIH criteria analyzed in selected studies

Authors (Year, country)	Age range (years)	Total patients MIH/ no MIH	Female MIH/no MIH	Male MIH/no MIH	Molars affected 1 (%)	2 (%)	3 (%)	4 (%)	Only Molars Affected (%)	Incisors and molars affected (%)
Farias et al (2021) (Brazil)	8-10	471(46/425)	265(26/239)	206(20/86)	52.2	26.2	13	8.6	54.2	45.8

Teixeira et al. (2018) (Brazil)	8-15	334(98/236)	NR	NR	NR	NR	NR	NR	NR	NR
Fatturi et al. (2020) (Brazil)	8	731(88/643)	357(39/318)	374(49/325)	NR	NR	NR	NR	NR	NR
Hernandez et al. (2018) (Spain)	11 months – 14 years	705(44/661)	330(27/303)	375(17/358)	NR	NR	NR	NR	NR	NR
Mejía et al. (2019) (Colombia)	6-15	1075(120/955)	443(46/397)	632(74/558)	NR	NR	NR	NR	NR	NR
Giuca et al. (2018) (Italy)	6-13	120(60/60)	68(35/33)	52(25/27)	NR	NR	NR	NR	46.7	53.3
Koruyucu et al. (2018) (Turkey)	8-11	1511(215/1296)	751(113/638)	760(102/658)	NR	NR	NR	NR	26	74
Thakur et al. (2020) (India)	8-16	2000(58/1942)	967(12/955)	1033(17/1016)	8.6	32.8	13.8	44.8	17.2	82.8
Andrade et al. (2017) (Brazil)	7-15	99(31/68)	NR	NR	NR	NR	NR	NR	NR	NR
Glódkowska et al. (2020) (Poland)	6-12	2275(212/2063)	97-MIH NO MIH - NR	115-MIH NO MIH - NR	NR	NR	NR	NR	NR	NR
Portella (2019) (Brazil)	8-10	728(88/640)	NR	NR	NR	NR	NR	NR	45.5	54.5
Reyes (2019) (Brazil)	8	731(88/643)	357(39/318)	374(49/325)	NR	NR	NR	NR	45.5	54.5

Therefore, the disturbance during enamel development can affect one of the molars and except the one on the opposite side. The impairment to a specific area of the tooth is probably due to accidental events that occur during enamel mineralization, a similar phenomenon encounter in other systems such as convolutions in the brain or fingerprint. On the other hand, the cervical third of the molars crown is rarely affected, which suggests for MIH disturbing mineralization of the crown occlusal area. These disruptions do not extend to the cervical area because molecular signals interpose towards the occlusal area that are related to the formation of the pulpo-dentinal complex. Frequent impairment of the vestibular surface could be

explained by a preferential targeting of molecular signals to the vestibular area, meaning that mineralization occurs with a geographical pattern, from the vestibular to the lingual and proximal areas [6].

Authors concluded that the occurrence of MIH syndrome is more common in pairs of monozygotic twins than in dizygotic twins, which emphasizes the genetic component of this disease [7]. At the same time, studies exhibit that people with genotype rs1784418-TT and C alleles and genotype CC of rs18000972 have a higher predisposition to MIH while the rs1311567GG genotype decreases the risk of MIH syndrome [8]. Genetic polymorphisms of vitamin D receptors have not been associated with MIH

or HSPM (Hypo mineralised Second Primary Molars). However, carriers of at least one G allele in rs739837 have been associated with an increased prevalence of the most severe phenotype (MIH affecting both molars and incisors) [9].

Studies designate that the etiological factors associated with MIH are the following: diseases during pregnancy, psychological stress, caesarean birth, complications at birth, respiratory diseases and fevers in children first years of life (chickenpox, otitis, atopic dermatitis), food allergies, complications in the last trimester of pregnancy, low birth weight, urinary tract infections, use of antibiotics during pregnancy, premature birth, frequent diarrhoea, systemic digestive disease, rubeola [10-18]. Celiac disease also increases the risk of developing MIH syndrome (the presence of MIH syndrome could be a diagnostic criterion for celiac disease) [19]. At the same time, patients with cleft lip and palate have a higher risk of developing MIH as well as those infected with HIV (Human Immunodeficiency Virus)

[20, 21]. Finally, it seems that pollution would also play an important role in the aetiology of MIH syndrome [22].

Classification

Defects caused by MIH syndrome are mild, moderate, or severe depending on whether or not dentin is exposed [3]. The enamel defect is in the form of a marked opacity of with variable colour changes: white, cream, yellow and brown [23]. The yellow or brown colour of the opacities signifies a higher degree of porosity than the white colour, consequently increasing the chance of enamel disintegration [3].

Diagnostic criteria

To diagnose MIH, 8 years of age is recommended, because all permanent molars should erupt by this age as well as most permanent incisors. To inspect the lesions caused by MIH, the teeth must be: clean and hydrated (moist) for a better enamel surface analysis. The main diagnostic criteria for MIH syndrome proposed by EAPD are systematized in Table 2.

Table 2. Criteria for diagnosing incisor molar hypo mineralization syndrome (MIH) proposed by EAPD [23]

Diagnosis criteria	Clinical feature
Impairment of the first permanent molars and permanent incisors.	At least one of the permanent molars must be affected Permanent incisors can be affected, at the same time. Temporary teeth can also be affected: second molars, incisors and canine tip.
Demarcated opacities.	Opacities located on the occlusal and vestibular surface of the crown. The colour of the opacities is variable: white, cream, yellow, brown.
Disintegration of enamel, dental hypersensitivity, damage to aesthetics depend	The severity of enamel defects depends on the opacity's degree of porosity.

on the severity of enamel defects.	Mild MIH syndrome: marked opacities without enamel breakdown, occasional sensitivity to external stimuli (but not to brushing) and a slight aesthetic impairment. Severe MIH syndrome: demarcated opacities that cause enamel disintegration, cavities grafted at this level, continuous or spontaneous hypersensitivity (also occurs during brushing) and aesthetic impairment that can have a psychological impact.
Atypical coronary restorations.	Atypical coronary restorations in the first permanent molars and incisors.
Dental extractions.	The presence of dental extractions is relevant for the diagnosis only if there is a medical history of MIH or there are opacities demarcated on another permanent molar.

Hypo mineralized enamel varies in colour but always has well-defined edges delimiting the lesion from healthy enamel. The porous enamel detached easily by the action of masticatory forces. Occasionally, the enamel breaks shortly after molars eruption, result in dentin exposure. For the incisors, the masticatory forces act less, that is why the enamel disintegration does not occur so frequently, but the extended defect location on the vestibular surface affects dental and facial aesthetics [24].

Hypo mineralized teeth have sensitivity leading to poor oral hygiene and increased risk of enamel fracture and decay. Toothache also causes a negative emotional impact on children. The well-marked hypo mineralized enamel defect, specific to MIH, can be present in both permanent and temporary teeth [4, 25]. Simultaneously, studies show that the demarcated opacities present in temporary teeth are a predictive factor for the occurrence of MIH in Table 3. Differential Diagnosis - MIH [24]

permanent dentition [26]. About a third of MIH lesions are severe and with increasing severity, the risk of caries augments [4]. The dental hypersensitivity of the molars affected by MIH is due to pulpal inflammation, attribute highlighted in extracted caries free molars with MIH. Immunocytochemical techniques bring to light changes in innervation, vascularization, and immune cell accumulation, indicatives of an inflammatory response [27].

The atypical restorations characteristic for MIH syndrome extends on the lingual or palatal surface and at the level of the incisors, vestibular restorations will be observed that cannot be correlated with a trauma [24].

Differential diagnosis

The differential diagnosis of MIH syndrome considered the following pathologies: amelogenesis imperfecta, enamel hypoplasia, fluorosis, opaque white spot (Table 3).

Pathology	Clinical feature
Amelogenesis imperfecta	It is present in both permanent and temporary teeth and is a genetically inherited defect.
Enamel hypoplasia	Hypoplastic lesions have regular fine edges and characteristic. MIH lesions have irregular sharp edges due to enamel disintegration.
Fluorosis	Teeth affected by fluorosis have diffuse opacity; MIH has well-marked opacity.
White spots	White spot occurs in vulnerable areas where bacterial plaque accumulates.

Discussions

According to evaluated literature data, MIH prevalence was considered around 13.5% and moderate to severe cases of MIH were estimated at 36.3% of all cases. When considering the prevalence among continents, as we only accounted for the EAPD classification, results are extremely different.

Also, we were unable to explore hypothetical MIH-related factors (both medical, sociodemographic and environmental) because of the lack of relevant information, and this should be taken into account in future epidemiological studies

For example, South America (18%) and Oceania (16.3%) have the highest prevalence rates as opposed to Europe (14.3%), Asia (13%) and Africa (10.9%). In contrast, no significant differences between genders (boys - 14.3%, girls - 14.4%) were noticed. Children aged 10 years or less had a considerably higher prevalence (15.1%) compared to children older than 10 years (12.1%). These findings suggest a possible involvement of ethnic, environmental, etiological factors that have a different Conflict of Interest. The authors state no conflict of interest.

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incidence in relation to the evaluated continents [28].

Authors proposed considered MIH a hereditary rather than an idiopathic condition. Mineralization of permanent first molars begin prenatal or perinatal and ends at the age of 4-5 years, and the abnormalities that occur during this period can cause the onset of MIH syndrome [29]. The diagnosis of MIH is challenging as the clinical appearance and the age, according to the importance of the teeth in dento-alveolar arch. [30].

Conclusions

Literature data take into account MIH as a public health problem, with painful, aesthetic, and a negative impact on the quality of life of individual's consequences. Considering the multiple etiological factors, the prevalence, the variety of clinical features and the association with increased caries risk, it is necessary for dentists to consider early and effective MIH diagnosis using the diagnostic criteria proposed by EAPD.

The diagnosis and management of MIH is challenging as the clinical appearance, and the individual discomfort varies widely

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