

Molar Incisor Hypomineralization in Children: A Review of Literature

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Abstract

Molar incisor hypomineralization (MIH), which refers to the clinical picture of hypomineralization of systemic origin affecting one or more first permanent molars (FPMs), frequently in association with affected incisors, is one of the major developmental defects of dental enamel. While this condition is of interest to clinical practitioners worldwide, there is little information regarding its prevalence and etiology, especially in the Middle East. The purpose of this review was to describe the prevalence and possible etiological factors of molar incisor hypomineralization in children. About 252 articles were reviewed as well as some references of selected articles. Twenty-six recent studies described the prevalence and possible etiological factors of molar incisor hypomineralization in children. The prevalence of MIH appears to be increasing and was associated with health problems during early childhood, including asthma, adenoid infection, tonsillitis, fevers, and antibiotic intake. Although the etiology may be multifactorial, children born preterm and those with poor general health or systemic conditions in their early life may develop MIH.

Keywords: Literature review; Molar; Incisor; Hypomineralization; Child

Introduction

Molar incisor hypomineralization (MIH) is one of the major developmental defects of dental enamel and describes the clinical picture of hypomineralization of systemic origin affecting one or more first permanent molars (FPMs), frequently in association with affected incisors [1]. The condition is attributed to disruption of ameloblastic activity during the transitional and maturational stages of amelogenesis [2]. These findings can result from a systemic upset during the first years of a child's life, more precisely during the period in which the crowns of the FPMs and incisors are mineralized [1-3].

MIH does not appear to be a new phenomenon, but when caries prevalence was high, the developmental defect responsible for initiation of the cavity was probably not diagnosed [4].

The number of affected FPMs varies, with one to four molars affected to varying degrees of severity [4-6]. The probability of involvement of the permanent incisors appears to be higher in cases in which greater numbers of FPMs are affected [7].

In the literature, MIH is also known cheese molars [8], dysmineralized FPMs [9], hypomineralized FPMs [3], nonfluoride hypomineralization [10] and idiopathic enamel hypomineralization [2]. Later, Weerheijm and co-workers suggested the term MIH for this enamel defect to facilitate comparison of the research related to these types of defects [1].

MIH has become a field of interest to clinical practitioners worldwide, yet there is little information regarding its prevalence and etiology, especially in the Middle East [11].

The purpose of this review was to describe the prevalence and possible etiological factors of MIH in children.

Material

Electronic search of English scientific papers from 1967 to 2013 was accomplished using Pub Med search engine. The following search terms used were: prevalence, etiology, etiological factors, molar, incisor, hypomineralization, and children. About 252 articles were reviewed as well as some references of selected articles. Twenty six recent studies

described the prevalence and possible etiological factors of MIH in children.

Discussion

Prevalence of molar incisor hypomineralization

Only limited data on the prevalence of MIH are available at this time, as children are not routinely screened for the presence of MIH-affected molars [4,12].

In the different studies, there are large variations in the reported prevalence of MIH ranging from 2.8% to 40.2%, which may reflect real differences between regions and countries [13-25]. However, they could conceivably be explained, at least partly, by different birth cohorts, different ages of the children at examination, local environmental circumstances, differences in methods, differences in diagnostic criteria and/ or whether hypoplasia and/or opacities were included [26].

Weerheijm and Mejare attempted to map the occurrence of MIH throughout Europe using a questionnaire sent to members of the European Academy of Paediatric Dentistry [26]. They found that MIH had been observed in all of the responding European countries, except for the Czech Republic. Crombie and co-workers distributed the same type of questionnaire to members of the Australian and New Zealand Society of Paediatric Dentistry and found that MIH was widely recognized [27]. However; studies from other parts of the world have recently been published. A search of the literature reveals that, to date, it seems that there is no prevalence studies conducted in North

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America and that only very few have been conducted in the region of the Middle East.

Etiology of molar incisor hypomineralization

Valid data on the prevalence of MIH could also justify prospective studies on the etiology of the defect, which remains unknown despite many different suggestions [12]. It is likely that MIH is not caused by one specific factor. Several harmful agents/conditions may act additively or even synergistically to increase the risk for MIH. The reality that the MIH prevalence varies among birth cohorts of different ages in multiple studies suggests that differences in environmental factors may contribute to the etiology of MIH. Because the clinical signs of MIH are fairly uniform, it is likely to be caused by several etiological factors [7].

As a rule, MIH defects cannot be related to well-known causes such as rickets, tetracycline-based discoloration, dental fluorosis, or amelogenesis imperfecta. Surveys on the etiology of MIH have not produced clear results. It has not been possible to name one singular influence or even a combination of several influences working together as being responsible for the disease [3]. Genetic and environmental factors have been proposed to contribute to MIH [28,29]. The environmental factors considered include illnesses occurring during mineralization of the FPMs and permanent incisors, such as fevers, chicken pox, ear infections, tonsillitis, asthma, and allergies [28]. Prenatal factors such as illnesses during pregnancy, premature birth, birth complications, antibiotic use during early childhood, and family history of "enamel defects" have been implicated as well [30].

Therefore, while the etiology of MIH is not yet fully understood, it seems to be associated with systemic disturbances during the peri- and postnatal phases or to non-specific diseases during the child's first 4 years (early childhood) [5,31]. The connection with MIH is especially strong for disorders associated with alterations in the calcium-phosphate balance or insufficient oxygen supply to the ameloblasts [3,28].

Research into the etiology of MIH has concentrated on an environmental insult occurring in the first 4 years of life because of the pattern of molars and incisors affected [31].

Hypomineralization is thought to follow deposition of the full thickness of the enamel matrix. The transitional ameloblast is considered most vulnerable. When these cells do not undergo complete maturation, full-thickness hypomineralization occurs [2]. Lack of calcium phosphate may also contribute to the formation of hypomineralized enamel [32,33].

Given the degree of enamel disruption that may present, an underlying prolonged systemic upset of ameloblast function is a likely explanation. Thus, a range of causative factors known to be associated with disrupted amelogenesis of FPMs includes systemic conditions and environmental insults influencing natal and early development [32].

Genetic and ethnic factors

Very few studies have investigated genetic or ethnic factors in the etiology of developmental defects of enamel (DDE). Mackay and Thomson found no significant difference between Maori and a non-Maori child in the prevalence of enamel defects, but the proportion of Maori in their sample (8%) was lower than that seen in the wider New Zealand population [34].

There seems to be agreement in the literature that the possible etiological factors are systemic, indeed the definition by Weerheijm

actually states as such [7]. However, recently in a questionnaire to members of the Australian and New Zealand Society of Paediatric Dentistry, just over half of the respondents thought that there as a genetic component to MIH [27]. Whatling and Fearnse seem to agree that there may be a genetic susceptibility, and suggested that family studies may provide further information [30].

Mahoney and Morrison found no statistically significant ethnic difference in MIH prevalence among the Maori, Pacific Island, and New Zealand European ethnic groups [20]. Therefore, it is not known at present whether there is a genetic component of the development of MIH that makes some individuals more susceptible to this condition. Clinicians should remain suspicious of possible genetic components, as there is still little evidence on this issue. Statistically, the frequency of MIH is relatively high in some child populations; furthermore, twins are likely to have more problems in the neonatal period. In addition, MIH is probably less prevalent among Asian children, but there are no studies evaluating whether this difference may have an ethnic component [35].

Prenatal factors

There is some evidence for association of MIH with medical problems during pregnancy (the prenatal period) [29]. Moreover; MIH was more common among children whose mothers had throat infections and high fever. Other studies did not associate MIH with specific diseases, but their authors reported that medical problems were more common in mothers of children with MIH than in mothers whose children did not have MIH [36,37].

Perinatal factors

Various medical conditions in the perinatal period may affect the welfare of the child either alone or in combination. In a Greek study, MIH was more frequently seen in children with perinatal problems/conditions (the most common were Caesarian section, prolonged delivery, premature birth, and twinning) than in the control group children [37]. On the other hand, studies in England and Germany could not link MIH with perinatal problems [5,30].

Preterm birth has been associated with an increased rate of enamel defects, including hypomineralization and hypoplasia, of the permanent dentition [9,38].

The results of the different studies are not always in agreement with each other [4]. Problems during pregnancy and birth have been mentioned, while in other studies no differences were found concerning the health of mother and child during pregnancy and birth of the children with and without MIH [28]. It has been shown that children born preterm also have an increased frequency of enamel defects in the permanent dentition [39].

Hypoxia can be associated with medical problems related to birth, such as prematurity, respiratory stress and excessively prolonged duration of birth. It has been suggested that the causative factor of MIH or opacities in molars and incisors, could have been oxygen lack in active ameloblasts [1,36,37].

Hypocalcaemia may occur during the perinatal period but also in prenatal and postnatal periods. The finding that calcium, but not so clearly phosphate, levels were very low in MIH lesions suggests that the defects were caused by impaired calcium metabolism of the ameloblasts [40].

Postnatal factors

Several reports suggest that postnatal medical problems are associated with MIH. Special attention has been paid to infectious childhood illnesses, high fever, medication (antibiotics), environmental toxicants, breast-feeding and use of fluorides. Conditions common in the first 4 years of life, such as upper respiratory diseases, asthma, pneumonia, otitis media, tonsillitis, chicken pox, measles, rubella, and urinary tract infections, appear to be associated with MIH, although controversial results exist concerning some specific illnesses [3,28,30,41].

In a Dutch case control study, children with MIH had more illnesses during the first 4 years of life than children without [28]. In addition, a Spanish study found that frequent paediatric care in each of the first 4 years of life correlated strongly with dental enamel defects in the FPMs [41].

Furthermore, postnatal problems during the first year were clearly more common in children with MIH than in those without in a Greek study [36,37]. In a Turkish study, children with MIH were more likely than those without to have a history of disease within the first 4 years of life [18].

Wogelius and co-workers investigated the association between use of asthma drugs and prevalence of demarcated opacities in the permanent first molars in 6-8 year old Danish children and concluded that the children who received prescriptions for inhaled asthma drugs before the age of 3 years had no overall increased risk for demarcated opacities in the first permanent molars but did seem to have increased risk for severe demarcated opacities [19].

Fever is a common symptom of infectious childhood illnesses, and its effects are therefore difficult to distinguish from those of the disease itself. However, an experimental study showed that an exogenous pyrogen, turpentine, induced enamel hypomineralization in rat incisors [42].

Vaccines given during early childhood have also been suggested as a possible cause of MIH, but no data are available to substantiate this etiology [4]. Antibiotic usage has also been implicated. Due to the concurrence of disease and antibiotic therapy, however, it is difficult to ascertain whether the MIH was associated with the disease or the antibiotic [43]. Some studies link antibiotic use with MIH [28,30,43]. The use of amoxicillin during the first year of life has been found to increase the risk for MIH and fluoride-like defects in the permanent incisors and FPMs [43-45]. Furthermore, in an English study, MIH was more common among children for whom amoxicillin was the only antibiotic they had received during the first 4 years, but not in children with mixed antibiotic use including amoxicillin [30]. In a Spanish study, the prevalence of MIH did not differ between children who had received amoxicillin during their first, second or third years and those who had not [41].

An experimental study suggested that a macrolide caused enamel defects in rats. They concluded that a hypomineralization zone in incisors was seen after 4 weeks indicating developmental toxicity of the macrolide [46].

Chawla and co-workers conducted a retrospective study of the dentitions of 182 children with hypomineralized first permanent molars and found that there is a possible association between MIH and combinations of antibiotic use, ear infections, fevers, perinatal conditions and other illnesses in the child's first three years of life [47].

Children with poor general health and systemic conditions are

more likely to have MIH [48,49]. The systemic conditions implicated to date include nutritional deficiencies, brain injury and neurologic defects, cystic fibrosis, syndromes of epilepsy and dementia (Kohlschutter-Tonz syndrome), nephrotic syndrome, atopia, lead poisoning, repaired cleft lip and palate, radiation treatment, rubella embryopathy, epidermolysis bullosa, ophthalmic conditions, celiac disease, and gastrointestinal disorders [49].

Environmental toxicants

Associations have been made between the presence of polychlorinated dibenzo-p-dioxins (PCDDs) in breast milk and enamel hypomineralization in both clinical and laboratory studies [31].

The suggested influence of prolonged breast-feeding on enamel formation could not be demonstrated in all studies [3,10,28]. Although other clinical studies have not found associations between dioxin compounds in breast milk and hypomineralized enamel, a positive association was demonstrated when 2, 3, 7, 8-tetrachlorodibenzo-p-dioxin was administered to lactating rats [50]. The arrested degradation and removal of matrix proteins resulted in protein retention and hypomineralized enamel [51]. Results from other Finnish or European studies have not suggested that duration of breast-feeding was associated with MIH [30].

Laisi and co-workers found that the exposure of a child via placenta/mother's milk to PCDD/Fs (At prevailing levels) is not associated with MIH [52]. Furthermore, a Turkish study showed a similar prevalence of MIH in children living in an urban area polluted by dioxins and in those living in an area with low pollution [53].

Fluorides

Fluoride is thought to affect enamel crystal formation mainly during the maturation stage inducing defects described as diffuse opacities [54]. A very substantial majority of studies have reported a strong association between the diffuse defects and the level of fluoride in drinking water or fluoride supplementation; however, no association between the prevalence of demarcated opacities and fluoride exposure has been found [34,55]. The association between fluoride supplementation and MIH was investigated; nevertheless, no significant association was found [30].

A review by William and co-workers stated that although the etiology is not known at this time, children who had poor general health in their first three years of life, who were born preterm or were exposed to certain environmental contaminants might be at risk for MIH [31]. Crombie and co-workers concluded that there is currently insufficient evidence in the literature to establish etiological factor/s relevant for MIH and that there was moderate evidence that polychlorinated biphenyl/dioxin exposure is involved in the etiology of MIH; weak evidence for the role of nutrition, birth and neonatal factors, and acute or chronic childhood illness/treatment; and very weak evidence to implicate fluoride or breastfeeding [56].

Conclusion

The prevalence of MIH appears to be increasing and was associated with health problems during early childhood, including asthma, adenoid infection, tonsillitis, fevers, and antibiotic intake. Although the etiology may be multifactorial, children born preterm and those with poor general health or systemic conditions in their early life may develop MIH.

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