REVIEW ARTICLE

MOLAR INCISOR HYPOMINERALISATION - A LITERATURE REVIEW

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ABSTRACT

Molar incisor hypomineralisation (MIH) is a common developmental dental condition that presents in childhood. This defect usually involves one to four permanent first molars and permanent incisors. The affected teeth are more prone to caries and post-eruptive enamel breakdown, therefore, it is believed that this condition might be responsible for a substantial proportion of childhood caries since the condition has high prevalence. However, the possibility of a genetic component in the development of MIH cannot be excluded. Management of MIH always pose a big problem to the clinicians, as well as for the child due to severe sensitivity caused by the defective enamel.

Keywords: Incisors, Management, Molar, Resin Infiltraion, Veneers

J Ind Dent Assoc Kochi 2022;4(1):12-9.

INTRODUCTION

Developmental defects of teeth are caused by complex interactions between genetic and environmental factors during tooth development.[1] Enamel is a unique hard tissue which does not undergo remodelling like bone and as a result the structure of enamel is affected during its formation permanently.[2] In recent years, site specific hypoplastic enamel disorders such as molar incisor hypomineralization (MIH) and hypomineralized second primary molars (HSPMs) have become serious concerns in pediatric dentistry.[3] The term molar-incisor hypomineralisation (MIH) was first introduced in 2001 by Weerheijm et al.[4] MIH was defined as 'hypomineralisation of systemic origin, presenting as demarcated, qualitative defects of enamel of one to four first permanent molars (FPMs) frequently associated with affected incisors.[5]

MIH is a hypomineralized defect of one to four first permanent molars and it occasionally involves permanent incisors. It is characterized by demarcated opacities with variable coloration, from white, cream, yellow to brown. The location is usually asymmetrical.[4] Consequently, these teeth may be very sensitive, undergo posteruptive tissue breakdown and be predisposed to caries. Associated opacities on anterior teeth are less likely to have functional problems but may result in cosmetic and psychosocial issues.[6]

Prevalence of MIH

The prevalence of MIH has been shown to range from 2.8% to 44% in different studies.[7] Among studies with more than 1000 subjects, the prevalence of MIH ranges from 2.8% to 21%. Overall, the prevalence of MIH varies by country, region and age group studied.[8] The worldwide prevalence is worryingly high (14.2%) and varies considerably from 0.5% in India to 40.2% in Brazil.[9] Weerheijm and Mejare reported a prevalence rate ranging from 3.6% to 25% after carrying out studies in European countries.[10] Later, a systematic review by Jalevik showed a wide variation in the prevalence of MIH between 2.4% and 40.2%. A non systematic online search and screening in the PubMed data base using the terms: European Academy of Pediatric Dentistry (EAPD); MIH; after the year 2003 showed prevalence of MIH ranging from 3.5% to 40.2%.[1]

Aetiology

MIH is a qualitative defect in enamel classified as hypomineralised type that follows the natural incremental lines of enamel formation, from cusp tip to cementoenamel junction.[1] MIH was initially described as an idiopathic defect but the causative mechanism of MIH is still unclear.[5] Most studies suggest that a combination of factors may affect ameloblasts, resulting in abnormal enamel formation leading to MIH.[11] The clinical presentation of localised and asymmetrical lesions suggests a systemic origin with the disruption in the amelogenesis process most probably occurring in the early maturation stage or even earlier at the late secretory phase.[12] Molar incisor hypomineralisation has no hypoplastic defects as there is no discernable reduction in enamel thickness. Any reduction in enamel thickness seen clinically is indicative of posteruption disintegration of enamel.[1]

The condition seems to be multifactorial and systemic factors such as acute or chronic illnesses or exposure to environmental pollutants during the last gestational trimester and first three years of life have been suggested as causative or contributing factors.[5] The number of affected teeth was associated with the time when the potential systemic disturbance occurred; children with prenatal, perinatal and postnatal problems showing more affected teeth in increasing order.[13] Multiple possible causes have been suggested in the literature, for instance, respiratory tract infections, perinatal complications, dioxins, oxygen starvation, low birth weight, calcium and phosphate metabolic disorders, frequent childhood diseases, use of antibiotics and prolonged breast feeding.[12]

Laboratory Findings

Hypomineralised enamel appears to have reduced hardness and elasticity, increased porosity, a higher protein content and an altered carbon:carbonate ratio. The relative abundance of serum albumin in yellow/brown hypomineralised enamel has also been reported as a notable finding and a potential inhibitor of enamel crystal growth.[14] Despite these laboratory investigations, questions remain about the depth and degree of defective enamel and the corresponding clinical presentation.[15] Furthermore, the scope of this

in vitro research is limited to extracted human molars, as anterior teeth are unlikely to be removed for clinical reasons.[6]

Molar Incisor Hypomineralisation and Dentin Pulp Complex [1,16,17]

After evaluation of various mineral content in hypomineralized tissue and comparing it with normal dentin it was found that Ca:P ratio of dentin below hypomineralised was almost identical to that of normal enamel, but when the Ca:C ratio was assessed, it was found to be low in dentin with an elevated level of C. The levels of O and P in dentin of normal teeth were found to be higher, but in hypomineralised teeth, dentin showed higher levels of N. Patients with MIH affected teeth suffer from dentine sensitivity to various thermal, mechanical and osmochemical stimuli due to the porous nature of enamel sometimes, exposing the dentin. This can favour ingress of bacterial contaminants thereby resulting in chronic inflammation of the pulp leading to a variety of morphological and cytochemical neuronal changes, with an over expressed dentin sensitivity.

Clinical Features [1,18,19,20]

Cervical enamel in most of cases is sound with no evidence of defective structure but if we see at a more occlusal level, the defect is confined to the inner enamel while the outer enamel does not appear to be affected. In the occlusal region, the hypomineralisation is more evident eventually spreading to the entire thickness of the enamel. The defects usually did not involve the cusp tips; the involvement of margin caused reduction in the height. An indicator of the severity of MIH affected teeth is the actual organic content of its enamel whereas brown enamel, the most severe form of MIH, has the highest protein content (15-21-fold greater), whilst the protein content of white/opaque and yellow enamel are both markedly higher (eight-fold greater) than sound enamel.

These microstructural changes in hypomineralised enamel improve the understanding of some of the problems associated with the clinical management of these teeth like the frequent occurrence of enamel fractures and inadequate retention of adhesive materials, both of which are recognized as significant clinical challenges.

Clinical Problems in MIH [5,20]

- The hypomineralized enamel will be softly porous and has a discolored chalky appearance
- Demarcated white/yellow/brown opacities usually limited to incisal or cuspal one third, rarely involving cervical one third. Defects that are <1 mm are not reported under MIH
- In molars, posteruptive enamel breakdown is common due to occlusal loading
- Rapid caries progression- because of the porous and friable enamel structure
- Adhesion of restoration material is poor
- Anesthetic difficulties: A combination of hypersensitivity and rapidly progressing caries causes chronic inflammation of the pulp, preventing effective local anesthesia
- Dental fear and anxiety can lead to behavioral management problems
- Esthetic problems in anterior teeth.
- Tooth Loss
- Occasional eruption difficulties of molars due to enamel roughness
- Negative impact on the child's school performance due to the absence from school
- Financial concerns for families

Diagnosis [6,21,22]

Determining a definitive diagnosis of MIH can be challenging, particularly in younger children in whom permanent teeth are still erupting, as the full distribution of any enamel defects will not yet be evident. So, the ideal time to diagnose MIH is as soon as it is clinically apparent either in primary or permanent dentition. The examination should be performed on clean wet teeth. The clinical presentation of MIH depends on its severity and can range from white-creamy opacities, yellow-brown opacities, post-eruptive enamel breakdown to atypical caries located on at least one FPM(first permanent molar) with or without incisor involvement. The lesions should be larger than 1 mm to be recorded as MIH. Mathu-Muju and Wright had classified

MIH into three severity levels:

- Mild MIH: the demarcated opacities located at non-stress bearing areas, no caries associated with the affected enamel, no hypersensitivity and incisor involvement is usually mild if present
- Moderate MIH: the demarcated opacities present on molars and incisors, the post-eruptive enamel breakdown limited to one or two surfaces without cuspal involvement, atypical restorations can be needed and normal dental sensitivity
- Severe MIH: post-eruptive enamel breakdown, crown destruction, caries associated with affected enamel, history of dental sensitivity and aesthetic concerns.

Differential Diagnosis

Conditions which can present with hypomineralised lesions and should be distinguished from MIH include:

- Fluorosis
- Traumatic Hypomineralisation
- White Spot Lesion
- Enamel Hypoplasia
- Amelogenesis Imperfecta[6]

Fluorosis[23]

Clinial picture of fluorosis is present as diffuse, linear, patchy or confluent white opacities without a clear boundary. The severity can range from barely perceptible striations in the enamel to gross disfiguration with almost complete loss of the external part of the enamel. It affects teeth in a symmetrical, bilateral pattern unlike MIH which is asymmetrical. but fluorosis affected teeth are caries-resistant while in MIH they are caries-prone.

Traumatic Hypomineralisation[20]

This is associated with a history of dental trauma to the primary predecessor tooth. Periapical infection of the primary tooth can disturb mineralisation of the underlying tooth germ. It has a wide variety of clinical presentations differing in shape, outline, localisation and colour. It is often limited to one tooth and asymmetrical.

White Spot Lesion5

This is the earliest clinical sign of caries. The lesions appear chalkier, matt or more opaque than the adjacent sound enamel. They can be distinguished from MIH because they occur in areas of plaque stagnation, such as the cervical margin of the tooth.

Enamel Hypoplasia[5]

This is a quantitative defect resulting reduced enamel thickness but in this case borders of hypoplastic enamel lesions are mostly regular and smooth, indicating developmental and pre-eruptive lack of enamel. The margins in MIH with post-eruptive enamel breakdown are sharp and irregular due to post-eruptive shearing of weakened enamel.

Amelogenesis Imperfecta[1]

This is a genetic condition which results in enamel that is hypoplastic, hypomature, or hypomineralised. In this condition, all teeth in both dentitions are affected and a familial history is often present.

Treatment of MIH [1,5]

For Molars:

- Resin Infiltration
- Restoration
- Full or Partial Coverage
- Extraction of severely affected Molars

For Incisors:

- Microabrasion
- Composite Restoration or Veneers
- Resin Infiltration
- Etch-Bleach Seal Technique
- Porcelain Veneers
- Tooth Bleaching

Treatment of Molars

Resin Infiltration[5,24,25,26]

It is also known as erosion infiltration. This

technique uses a very low viscosity resin which is capable of penetrating demineralised enamel. Icon®resin infiltration (DMG America, Englewood, NJ, USA) is commercially available for aesthetic restoration of MIH affected incisors. The Icon system consists of Icon-Etch (15% hydrochloric acid), Icon-Dry (99% ethanol) and Icon-Infiltrant (Methacrylate-based resin). Use of hydrochloric acid eliminates the relatively intact surface layer resulting in open access to the body of the lesion, then the fluid resin is infiltrated into the broad channels of communication. This material could protect against acid attack, improve enamel micromechanical properties and decrease post-eruptive enamel breakdown and/or possible improvement in bonding and restorative outcomes.

Crombie et al. suggest that in MIH molars, the resin infiltrant has the potential to penetrate surfaces like hypomineralised cuspal inclines which are susceptible to post eruptive enamel breakdown without interfering with occlusion or being broken by occlusal forces so this material can be effective if used as 'fissure sealant', but the material here will be infiltrated into the hypomineralised enamel therefore this procedure, if done, is irreversible and it requires excellent isolation. As severity of MIH increases porosity increases resulting in more infiltrartion of resin. Increasing etching time could be needed in MIH cases as suggested by Kumar et al.

The main disadvantages of RC are the following: shrinkage due to the extent of the restoration, reduced strength due to impaired bond strength, microleakage, occlusal wear and restoration durability.

Restorations[11,20,27,28]

When restoring hypomineralised teeth, dentists frequently face difficulty in defining the cavity margins. When treating MIH affected teeth, the cavity design should involve removal of not just discolored enamel, but all porous enamel until resistance is felt. The rationale for this approach is that defective enamel remnants compromise the results. The choice of the materials depends on the severity of the defect and the cooperation of the child. Adhesive materials are selected due to the atypical cavity outlines following removal of hypomineralized enamel. Glass ionomer cement (GIC) or resin modified GIC restorations can be considered only as an intermediate approach until definitive restoration is placed.

Resin composite is the material of choice and recommended for one to three surface restorations and the pre-treatment with 5.25% sodium hypochlorite can improve the bond strength. The resin composite has shown long-term stability compared with other restorative materials in MIH-affected teeth. Bond strengths of resin composite to affected MIH enamel, however, are significantly lower than bond strengths to sound enamel for both single bottle total-etch and self-etching primer adhesives. The resin composite for hypomineralized enamel is susceptible to wear and marginal fractures. Therefore, long term maintenance is required. Amalgam should be avoided due to atypically shaped cavities in MIH molars so further breakdown often occurs at the margins, it is a non-adhesive so does not restore the strength of the tooth and is a poor insulator.

Full or Partial Coverage [27,29,30]

In moderate to severely damaged MIH affected molars, full coverage restorations with a preformed metal crown (PMC) are the treatment of choice in a grown-up. PMCs can prevent further post-eruptive enamel breakdown, manage sensitivity, are not expensive, can establish correct interproximal and occlusal contacts, require no/little tooth preparation, and can be done in single visit. Non-precious metal, gold or tooth-coloured indirect onlays can be used in older children but the procedure is time consuming, technique sensitive and expensive. Preformed malleable composite temporary crowns that come in different sizes (Protemp Crown Temporisation Material by 3M ESPE) can offer an aesthetic option, some tooth preparation is required and the crown will require some adjustments but the process is considered easy and requires a single visit. There are as yet no studies that assess the performance of these crowns in MIH molars.

Extraction of severely affected Molars[31,32]

For severely affected FPMs with poor prognosis, extraction might be considered at the dental age of eight to ten years.[57] This will give the second permanent molars (SPM) an

opportunity to drift into the FPM position. It has been suggested that the ideal timing of FPM extraction is indicated radiographically by the calcification of the bifurcation of the roots of the lower SPMs. The chance of ideal positioning of the SPMs after the extraction of FPMs at the ideal time is 94% for upper SPMs and 66% for lower SPMs.

Treatment of Incisors

Microabrasion[11,33,34]

Microabrasion is effective in addressing the aesthetic concerns associated with incisors affected by mild MIH. Microabrasion involves the removal of a small amount of surface enamel(<100 µm) and erosion using 18% hydrochloric or 37.5% phosphoric acid with an abrasive paste. The process abrades the surface enamel while also polishing it which leads to changes in optical properties and this may improve the aesthetics. Microabrasion is indicated when the discolouration is limited to the outer surface of enamel and it is more effective at eliminating brown mottling. Home application of CPP-ACP after microabrasion was found to improve remineralization of the treated enamel surface. However, this microabrasion is limited to the superficial layer (shallow defects) of hypomineralized enamel.

Composite Restoration or Veneers[20,27]

Composite restorations involve removal of defective enamel and composite resin build-up using opaque resins to avoid excessive enamel reduction, while composite veneers could be a more conservative approach as it can be achieved with no tooth preparation that is, no removal of even defective enamel. These options could be indicated for large enamel defects that require treatment due to exposed dentine or chipped enamel. Pre-treatment with 5.25% sodium hypochlorite for one minute after etching can significantly improve bond strength . Therefore, long term maintenance is required as composite resins are susceptible to discolouration, wear and marginal fractures.

Resin Infiltration[25,26,35]

Since the refractive index of the resin infiltrant (1.52) is close to that of healthy enamel (1.62), this can improve the optical properties by improving the translucency and therefore improving the aesthetics. Attal et al suggested a modification in this technique for aesthetic management of MIH incisors and this was introduced as 'deep resin infiltration technique.' The technique involves preparing the affected tooth by an intraoral sandblasting device to ensure that the infiltration can indeed reach the full extent of the lesion in case of MIH. This should remove no more than 500 µm from surface enamel and after resin infiltration, some composite could be added to tooth surface. In general, the use of resin infiltration technique in MIH teeth requires further investigation, improvement in material properties and/or technique modifications to be strongly recommended in MIH cases.

Etch-Bleach Seal Technique[27,36]

Wright suggested this technique to remove yellow-brown stains. The affected tooth should be etched first with 37% phosphoric acid for 60 seconds, followed by continuous application of 5% sodium hypochlorite as the bleaching agent for five to ten minutes. Then the tooth should be re-etched and covered with a protective layer such as clear fissure sealant or composite bonding agent. With this technique the yellow-brown stains can be eliminated leaving a white mottled appearance which is more aesthetically acceptable.

Porcelain Veneers[5]

These are indicated for patients aged 18 years and above when the gingival margin has matured. It can be an option when the other techniques failed to produce satisfactory results.

Tooth Bleaching[27,37]

This option is indicated for adolescents. The possible side-effects of bleaching are: sensitivity, mucosal irritation, and enamel surface alterations. Home bleaching through daily placement of 10% carbamide peroxide gel into custom fitted trays is the gentlest bleaching option prescribed by the dentist, but for more protection, the combined use of CPP-ACP Tooth Mousse and bleaching gel is recommended. The CPP-ACP Tooth Mousse will protect the tooth structure and remineralise

the MIH opacities during the bleaching process without interfering with bleaching effect. The combined use of hydrogen peroxide and CPP-ACP, could be done with a ratio range from 1:6 to 3:4, depending on the opacity response to the bleaching agent

Future Prospects of MIH[11,38]

A combination of factors may affect the occurrence of MIH and result in abnormal enamel formation. Although MIH was initially described as an idiopathic defect, it has recently been proposed that it is a genetic condition. A possible association has been observed between MIH and variations in the AMBN, ENAM, TUFT1, TFIP11, and SCUBE1 genes. However, one study indicated that environmental factors are also associated with the occurrence of MIH. HSPM and MIH share a similar clinical presentation, structural properties and putative etiology.

CONCLUSION

MIH is a common childhood condition that presents a unique set of clinical challenges to dental health professional that is why good understanding about the etiology, early diagnosis specifically by differentiating from other enamel defects and appropriate treatment are essential for proper and effective management of MIH. But as we know every field require continuous research and evidences for proper effectiveness of treatment and long term management .

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