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Molar-Incisor Hypomineralization (MIH): Prevalence, Clinical Characteristics and Etiology in 8- to 12-Year-Old Children of Thiruvananthapuram, India

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Abstract

Objective: To assess the prevalence, clinical characteristics and risk factors associated with MIH defects, in children aged 8 - 12 years of a sub district in Thiruvananthapuram, Kerala.

Study Design: 1200 school children in the age group of 8 to 12 were examined from Nedumangad educational sub-district of Thiruvananthapuram, Kerala. The first permanent molar and permanent incisors were examined for demarcated opacities, post-eruptive breakdown, atypical restorations, and extracted first permanent molar. Children were considered to have MIH if one or more first permanent molar with or without involvement of incisors met the diagnostic criteria. Parents of those children who were diagnosed with MIH and an equal number of socio-demographically matched control population, completed a questionnaire which elicited presence of various etiological factors associated with MIH.

Results and Conclusion: MIH is observed in about 5.5% of the children examined. The occurrence of MIH is significantly associated with medical problems during pregnancy, medical problems or difficulties during delivery for mother, birth time complications in child, hypoxia at time of birth, maternal diabetes after delivery, use of incubator soon after delivery of the child and history of hospitalization due to high fever during the first 3 years of childs life.

Keywords: *MIH Prevalence; Clinical Characteristics; Etiology*

Introduction

Molar-Incisor Hypomineralisation (MIH) is a relatively new entity first described by Weerheijm., *et al*. in 2001. The first permanent molars with creamy-white to yellow-brown enamel opacities, in combination with disintegration, are observed frequently. One to four molars, and sometimes the incisors, can be affected. This condition recognized as a distinct phenomenon unlike other enamel disturbances is known as molar-incisor hypomineralisation [1].

A random review of articles reveals a large number of terms which were so far used to describe this particular condition. Some of these terms were hypomineralised first permanent molar, idiopathic enamel hypomineralisation, nonfluoride hypomineralisation and cheese

molars. Clinically, the lesion may present as a demarcated creamy white or yellow opacities to brownish defects with or without loss of enamel. The enamel breakdown of the affected tooth occurs soon after eruption and very often molars easily undergo post eruptive break down (PEB) when compared to anterior teeth [2].

Prevalence rates of MIH vary considerably throughout the world and range from 2.4% to 40.2% with the highest prevalence reported in Rio de Janeiro, Brazil [3]. Large number of MIH prevalence studies has been conducted in Europe. But there is a severe deficiency regarding MIH prevalence data in Indian populations. Hence, the present study intended to find out the prevalence of MIH in a young, Indian population of an educational sub district in the capital city of Kerala, Thiruvananthapuram and to define the clinical features, severity and distribution of defects.

Aim of the Study

The study also aimed to collect information regarding the various etiological factors associated with MIH with the help of a questionnaire.

Materials and Methods

1200 children from 7 schools belonging to government, aided and unaided schools were selected randomly from the sub district. Before the start of the survey, permission was obtained from the school Principals to conduct the survey in the schools and ethical clearance was obtained from Institutional Review Board. Head of institutions were contacted via written letters explaining the condition MIH and its consequences, giving appropriate emphasis on early diagnosis and treatment. A similar letter explaining the condition and seeking consent was circulated amongst parents of the school children. Cohorts of children born during 2000 - 2005 attending the selected schools in the academic year 2013-14 were included in the study.

Inclusion criteria

- All school children between 8 - 12 and their parents who are willing to participate in the study.

Exclusion criteria

- Parents and children not willing to participate in the study
- Children with amelogenesis imperfecta, fluorosis, white spot lesion
- Children who are not in the age group of 8 - 12.

Training and calibration of examiner

The examination of the entire study sample was performed by a single examiner. The investigator was familiarized with the index during patient examination in the outpatient department and by showing old patient records.

Study setting and examination criteria

1200 children from the 7 institutions were examined and evaluated during the school hours in adequate natural day light. Examination was performed using a mouth mirror and a blunt ended probe without drying the teeth. Buccal, lingual/palatal and occlusal surfaces of the first permanent molar and the labial, lingual/ palatal surfaces of upper and lower permanent incisors were examined. A tooth was considered erupted when more than half of the crown was visible in the oral cavity. A positive diagnosis of MIH was made when a subject presented with a demarcated defect on at least one of the erupted first permanent molar. EAPD 2003 criteria for diagnosis of MIH were adopted by the principal investigator.

EAPD approved diagnostic criteria for MIH (Weerheijm 2003) [1]

8 incisors and 4 first permanent molars are to be examined according to this criteria.

Each tooth should be examined for:

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

The severity of MIH was determined by the criteria used initially by Jasulaityte., *et al*. [7] and recently included in the EAPD recommendations [4]. According to these criteria mild cases are recorded as demarcated enamel opacities without enamel breakdown, occasional sensitivity to external stimuli e.g. air/water but not brushing and only mild aesthetic concerns of discolouration of the incisors. In severe cases there are demarcated enamel opacities with breakdown, caries, and persistent/spontaneous hypersensitivity affecting function [4].

Record keeping method: The data for each patient was entered on pre-printed pro forma and had the subject's demographic characteristics, eruption status of index teeth, scores assigned as per EAPD criteria and PEB.

Risk factor assessment: With the help of a questionnaire comprising of 14 questions and 6 sub questions the possible etiological factors were elicited from the parents of the children diagnosed with MIH. The questionnaires were distributed through the children to their parents and were asked to return the completed questionnaires back to their respective class teachers, and were collectively retrieved from various schools.

Control population: Once the prevalence rate was determined, an equal number of control population was also selected to compare and evaluate various etiological factors associated with MIH.A separate group of children was selected from the same child population and examined in the Out Patient Department of Pedodontics and Preventive Dentistry, as a control group. Accordingly, 66 children examined exclusively for orthodontic problems were included in the control group to make sure that the control group was totally free from MIH. In order to form a random and representative control group, children were matched for age, gender and ethnicity. In a consistent way every 5^{th} 'normal' child who was fulfilling the previously mentioned criteria was included in the 'control' group. Medical information of the child and the mother was retrieved the same way as for the MIH children.

Sample size: The sample size for the present study was calculated using the formula:

$E = Z \alpha^2 p (100-p) / d^2$

p = Anticipated prevalence of disease

d = Tolerable error in the estimate of p; usually it is 10 - 20% of p

α = Type 1 error.

With an error of 20% the samples size required for the present study was calculated as 996 and a total of 1200 subjects were included for screening after considering non response rate.

Statistical analysis: Data was analyzed using suitable computer software and appropriate statistical tools were used for analysis. Prevalence of MIH was expressed in terms of percentage with 95% confidence interval. Following statistical tests were used for analyzing the data:

- Chi square analysis
- Student's t test/Mann Whitney U tests based on the type of distribution of data
- Etiological factors were determined by finding odd's ratio.

Results

Distribution of the subjects by age and gender: The age range of the children examined having all index teeth present (4 FPM and 8 incisors) was 8 - 12 yrs. The mean age of sample was 10.37 years for males (SD ± 1.399) and 10.27 for females (SD ± 1.419). Of the study sample 580 (48.33%) were females and the remaining 620 (51.66%) males.

Prevalence of MIH: Out of the total number of children examined (n = 1,200), 66 were diagnosed with MIH, revealing a prevalence of 5.5% in the educational sub district. There was no statistically significant difference (p = .980) regarding the gender, as males and females were equally affected. Regarding the age distribution, 9-year-old age children had a statistically significant (p = 0.007) higher MIH prevalence (9.8%), as compared with the rest of the age groups where the prevalence was in the range of 2.8 - 7% (Figure 1).

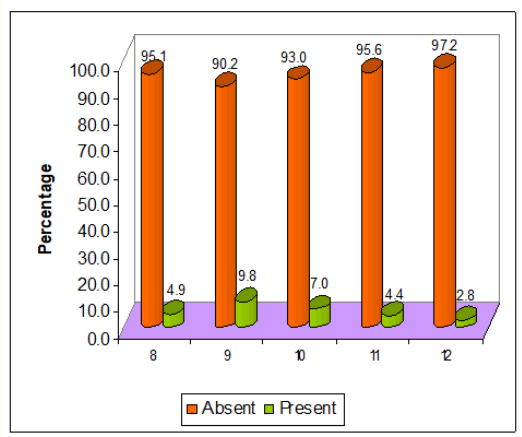
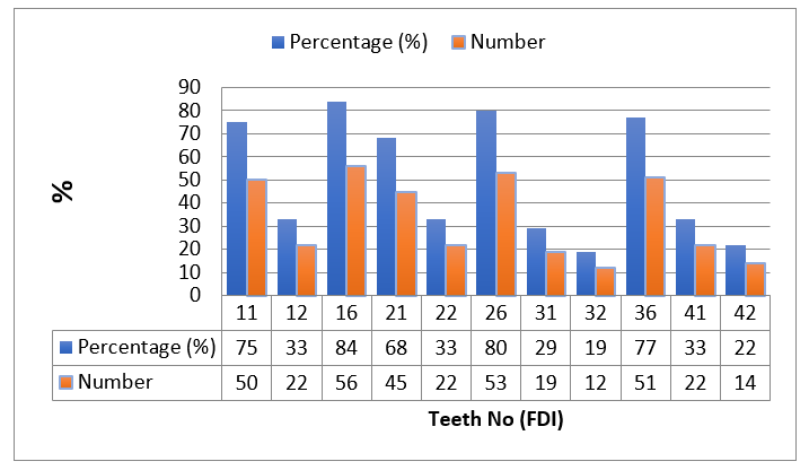


Figure 1: *Comparison between age in MIH affected children.*

Tooth types affected by MIH: The 66 children having MIH revealed 422 affected teeth- 216 molars and 206 incisors. In the molar group the most commonly affected tooth was the mandibular and maxillary right first permanent molar (56 teeth each), followed in descending order by the maxillary left (53 teeth), and mandibular left first permanent molar (51 teeth), revealing that maxillary molars were more frequently affected than mandibular molars. But this finding was not found to be statistically significant (p = .653).

In the incisor group the most commonly affected tooth was the maxillary right permanent central incisor (50 teeth) followed by the left permanent central incisor (45 teeth). The remaining permanent incisors revealed much lower frequencies ranging from 12 - 22 teeth (Figure 2).



	11	12	16	21	22	26	31	32	36	41	42
Percentage (%)	75	33	84	68	33	80	29	19	77	33	22
Number	50	22	56	45	22	53	19	12	51	22	14

Figure 2: *Number and percentage of affected teeth in children with MIH.*

Overall affected teeth were more frequently found in the maxilla (248 teeth) as compared to the mandible (174 teeth) and was found to be statistically significant (p = 0.008); at the same time, the right side revealed more affected teeth than the left, but this comparison did not show any significant difference statically (p = 0.070).

Severity level of affected teeth: All 206 affected incisors revealed mild defects, as compared to only 67.5% (146) of the molars being mildly affected, with the remaining 32.5% (70) revealed severe defects (Figure 3). Overall, mild defects were found in 351/422 (83.1%) of affected teeth and severe defects in 171/422 (16.8%). Also, the total number of affected teeth and the percentage of severely affected teeth increased with increasing age of the children (Figure 4).

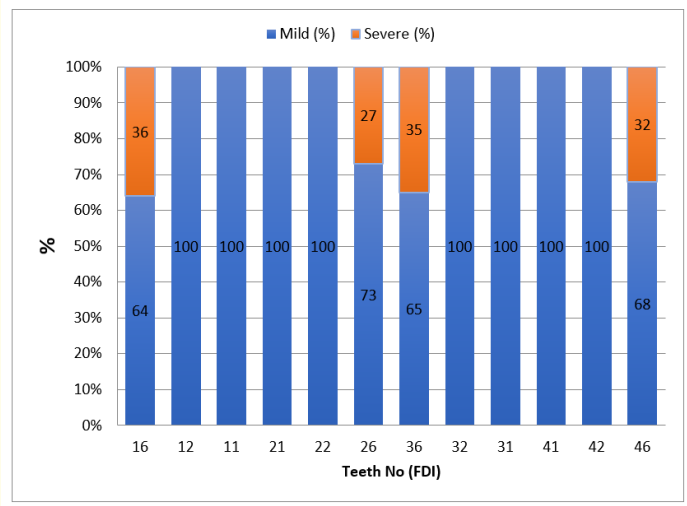
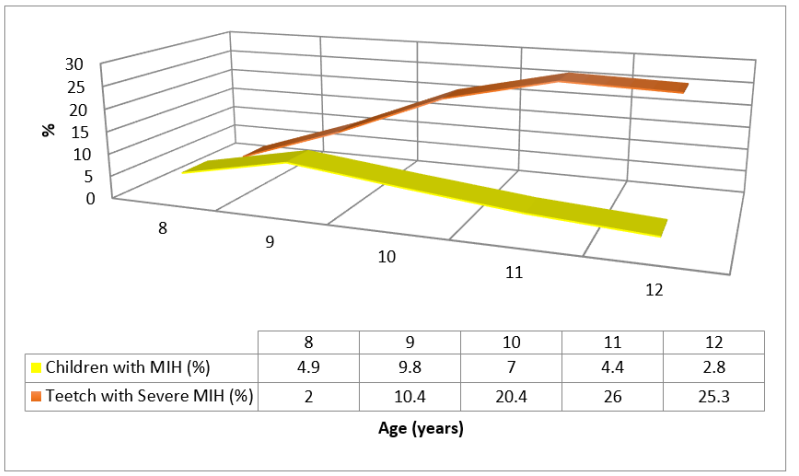


Figure 3: *Percentage of severity of different affected teeth in children with MIH.*



	8	9	10	11	12
Children with MIH (%)	4.9	9.8	7	4.4	2.8
Teetch with Severe MIH (%)	2	10.4	20.4	26	25.3

Age (years)

Figure 4: *Percentage of affected and severely affected teeth in children with MIH by age.*

Risk factor assessment: A retrospective study of the various etiological factors associated with MIH was done using a questionnaire, which interviewed the mothers of the affected children, regarding their prenatal, perinatal and postnatal histories. These questionnaires searched the association of various risk factors of MIH in the group of 66 affected children and an equal number of selected control population. Analysis of the total 132 questionnaires revealed that MIH was significantly more common among those children whose mother had problems during pregnancy ($p = .001$) and during delivery ($p = .016$). Statistically significant association was also found between MIH and other risk factors like hypoxia at birth ($p = .007$) and history of hospitalizations due to high fever before 3 years ($p = .020$). Statistically significant association was also more commonly found in those children who were placed in an incubator immediately after birth ($p = .011$) and those whose mothers had diabetes during post delivery period ($p = .023$).

No significant associations were found between MIH and various other risk factors like severe vomiting during pregnancy, gestational diabetes, maternal hypertension, caesarean section delivery, pre term delivery, low birth weight, and history of other childhood diseases (before 3 years of age) like chicken pox, pneumonia, otitis media, thyroid disorders, tuberculosis and upper respiratory diseases like tonsillitis and asthma.

Discussion and Conclusion

The aim of the present study was to determine the prevalence, severity and clinical characteristics of MIH in an Indian child population residing in the rural area of an educational sub-district in Thiruvananthapuram and to find out various etiological factors associated with MIH.

The findings of this study indicate that MIH is common among children in this area, revealing approximately one in twenty children being affected by the defect. Majority of the patients reporting to the Department of Pedodontics and Preventive Dentistry of the PMS College of Dental Science and Research with carious first permanent molar were surprisingly found to have MIH. Most of these patients were found to hail from the Nedumangad sub-district of Thiruvananthapuram. Hence, the present study attempted to determine the prevalence of MIH in a young, Indian population of Nedumangad educational sub- district, Kerala. This educational sub-district has a large number

Risk factors	Control	MIH	Odds (95% CI)	p
Severe vomiting during pregnancy	22 (33.3)	20 (30.3)	1.15 (0.55 - 2.39)	0.709
Gestational diabetes	3 (4.5)	8 (12.1)	2.89 (0.73 - 11.43)	0.115
Child's mother diabetic after pregnancy	0 (0)	5 (7.6)	1451.71 (0 - 0)	0.023
High blood pressure during pregnancy	8 (12.1)	13 (19.7)	1.78 (0.68 - 4.63)	0.234
Medical problems during pregnancy	1 (1.5)	13 (19.7)	15.94 (2.02 - 125.81)	0.001
Delivery type: normal	22 (33.3)	22 (33.3)	1.00 (0.49 - 2.06)	1.000
Full term delivery	58 (87.9)	58 (87.9)	1.00 (0.35 - 2.84)	1.000
Medical problems or difficulties during delivery for mother	1 (1.5)	8 (12.1)	8.94 (1.09 - 73.50)	0.016
Low birth weight	2 (3)	5 (7.6)	2.62 (0.49 - 14.02)	0.244
Birth time complications in child	4 (6.1)	11 (16.7)	3.10 (0.93 - 10.30)	0.055
Hypoxia at time of birth	0 (0)	7 (10.6)	4082.97 (0 - 0)	0.007
Child placed in an incubator after delivery	4 (6.1)	14 (21.2)	4.17 (1.29 - 13.46)	0.011
History of hospitalisation due to high fever when child was less than 3 years old	6 (9.1)	16 (24.2)	3.20 (1.17 - 8.79)	0.020
History of asthma before 3 years old	7 (10.6)	7 (10.6)	1.00 (0.33 - 3.03)	1.000
History of Chicken pox before 3 years old	8 (12.1)	9 (13.6)	1.15 (0.41 - 3.18)	0.795
History of Ear infections before 3 years old	9 (13.6)	12 (18.2)	1.41 (0.55 - 3.61)	0.475
History of Pneumonia before 3 years old	3 (4.5)	5 (7.6)	1.72 (0.39 - 7.52)	0.466
History of Tonsillitis before 3 years old	5 (7.6)	6 (9.1)	1.22 (0.35 - 4.21)	0.753
History of Thyroid diseases before 3 years old	3 (4.5)	3 (4.5)	1.00 (0.19 - 5.15)	1.000
History of Tuberculosis before 3 years old	3 (4.5)	3 (4.5)	1.00 (0.19 - 5.15)	1.000

Table 1: *The distribution of various risk factors among children within the molar incisor hypomineralization (MIH) and the control groups (summary).*

of schools belonging to the government, aided and unaided sectors. A sample size of 1200 was decided after doing a stratified multi stage sampling to ensure representation of all geographic areas in the sub district and to include participants from various sectors of schools.

In addition, regarding the selection criteria and the different age cohorts examined in the present study, the study design followed to a certain degree the recent recommendations of the EAPD regarding MIH prevalence studies [3,4].

When comparing the prevalence rate (5.5%) with other studies using the same diagnostic criteria, a higher prevalence rate of 9.2% was observed in a study from Gujarat, India [5]. A very recent study from Rajasthan reports a similar prevalence rate of 9.46% as compared to the study from Western region of India [6]. The prevalence rate of 6.3% reported from northern region of India, using 2009 revised EAPD criteria in a study by N. P. Mittal, was slightly comparable to the prevalence rate from the present study [2].

Evaluating the results concerning the type of teeth affected, it appears that only 4% of the affected children had MH, while 96% revealed the full MIH spectrum. This percentage is much lower than in all previous reports, where MIH children having only molars affected varied from 22.6 - 35% [7-9]. In the present study more maxillary teeth in total were affected compared to the mandibular, and when

molars were evaluated, maxillary teeth were more affected than mandibular teeth. The great majority (83.1%) of the affected teeth in the present study revealed mild defects, using the classification adopted by the EAPD in 2010 [7,10,11]. Finally the present study revealed that the degree of severity of affected molars increased with age, though a slight dip in severity was observed between the last two age groups.

Many studies have attempted to single out a specific etiology for MIH and researchers have not succeeded so far in pointing out a single definitive etiology. In this questionnaire-based study, MIH was significantly more common among those whose mothers who had experienced problems during pregnancy (P = 0.001). In this study, however, when the results were split down into the possible problems occurring in pregnancy, for example, gestational diabetes and hypertension, no significant differences were found between the cases and the controls [12].

No associations were found between MIH and severe vomiting during pregnancy, prematurity, delivery requiring induction, mode of delivery and birth weight categories. However, the present study revealed association between MIH affected children and birth time complications and medical problems related to birth like hypoxia at the time of birth [13-15]. Also, MIH was more commonly found among those children who had a history of hospitalizations due to high fever during the first 3 years of life [16]. The questionnaire revealed that more than 20% of children were placed in an incubator immediately after birth for some time. This association, though mentioned in the literature as a possible risk factor, is not proved conclusively to cause MIH. But, the results of the present study show a significant association between the two [17].

Gestational diabetes is a more commonly intrigued risk factor for MIH. But none of the studies related occurrence of MIH to maternal diabetes after gestational period. The present study is probably the first one to suggest such a possible association. In any study with a large number of questions, at least one variable may appear to be significant by chance. This particular association found between MIH and maternal diabetes after gestational period may also occur by chance.

No association was found between whether or not the child had suffered from chickenpox or its severity. Unlike in earlier studies, no association was found with regard to otitis media, respiratory infections and asthma [12]. Though pneumonia, tonsillitis, thyroid disorders and tuberculosis have been mentioned in the literature as positively linked with the etiology of MIH, the present study failed to suggest any significant correlation between these variables and MIH.

It should be remembered that this was a retrospective study and depended on the memories of the mothers interviewed. The data thus obtained will never be a complete reflection of the child's medical history over the first 4 years of life. Also, this study concentrated on a very small sub district in Kerala, which only represents a very minor portion of the entire nation of India. The data obtained from this trial is not at all representative of the whole country. There is definitely a scarcity of reports on MIH in our population and national surveys to map the prevalence of MIH are required. Prospective studies are also required to find the prognostic outcomes and gain an insight into the etiology of MIH.

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