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Original article:

Prevalence of Molar Incisor Hypomineralization amongst 8 to 11 years old government school children in Pune, Maharashtra- A cross-sectional study

Dr.Mahima Bulani B.[1], Dr.Sahana Hegde Shetiya [2], Dr.Deepti Agarwal [3]

[1]Past PG student, Dr.D Y Patil Dental College and Hospital, Pimpri, Pune

[2]Professor and Head, Department of Public Health Dentistry, Dr.D Y Patil Dental College and Hospital, Dr. D Y Patil Vidyapeeth, Pimpri, Pune

[3]Ex Reader, Dr. D Y Patil Dental College and Hospital, Pimpri, Pune

Corresponding author : Dr. Sahana Hegde Shetiya ; Email:sahana.hegde@dpu.edu.in

ABSTRACT:

Background: Molar-Incisor Hypomineralisation (MIH) is a developmental defect of systemic origin involving hypomineralization of enamel of first permanent molars with or without involvement of incisors leading to increased sensitivity and caries risk, thus, making it essential to map its occurrence in the Indian population. It is a condition which dentists need to be aware of and apply measures to prevent caries and hence the study was planned with the aim of mapping its prevalence.

Material and Methods: A cross-sectional study was conducted amongst 1400 government school children aged 8 to 11 years in Pune after obtaining permission from the government school authorities and consent from parents of children. Oral examination was conducted by a single trained and calibrated examiner according to type III clinical examination using European Academy of Pediatric Dentistry (EAPD) criteria for assessment of MIH among the permanent index teeth. Severity of MIH was also determined. MIH-Caries (MIH-C) was assessed using WHO criteria,1997 for the detection of caries. Data was analyzed and expressed in percentages.

Results: Prevalence of MIH and MIH-C was 7.4% and 2.2% respectively.The most commonly affected molar was mandibular right first permanent molar and amongst the incisors was maxillary right central incisor. 36.9% of the diagnosed cases involved only molar hypomineralization (MH) while 63.10% involved both molar and incisor hypomineralization (MIH). Mild defects were seen on 59.22% of the affected teeth while 40.78% teeth had severe defects. MIH-C was found in 30.1% of MIH affected cases.

Conclusion: Mild MIH, Demarcated opacities in the molar was more often seen and 30% of children with MIH had caries. MIH was most prevalent in mandibular molars and upper central incisors. Older the age, higher was the prevalence of MIH. Preventive dentistry needs to be emphasized upon due to susceptibility of MIH to caries

Key words: Dental caries, Molar Incisor Hypomineralisation , Prevalence

Introduction:

Tooth development and mineralization starts before birth in humans and continues to adolescence when the permanent molars complete their mineralization.[1] The high mineral content in the vertebrate body, makes the dental enamel the hardest tissue.[2]

However, a disturbance arising in the enamel matrix formation and mineralization during odontogenesis is defined as a Developmental Defect of Enamel.[1]

The term Molar-Incisor Hypomineralisation (MIH) was coined by Weerheijm et al in 2001

at the 5th Congress of the European Academy of Pediatric Dentistry (EAPD). [3] It was first recognized by Swedish dentists in the late 1970s. Thereafter, Ogden et al in 2007 found MIH-like lesions in children from the 16th to 18th century when they examined the bodies excavated from a London graveyard. The defect may be susceptible to high risk of dental caries with sensitivity of the affected teeth because of the soft and porous enamel, which is due to post-eruptive breakdown and may also present as demarcated opacities. [4] Thus, MIH needs to be diagnosed at an early stage in order to treat it.

The development of MIH is of great relevance in public health dentistry. The reduction in the prevalence of acquired developmental anomalies of teeth is one of the targets to be achieved according to the Global goals for Oral Health 2020. [5] Early diagnosis of MIH will help in taking preventive measures such as maintenance of good oral hygiene, topical fluoride application which will help to arrest its further progression and severity. [6]

Europe has reported most of the prevalence studies regarding MIH with the prevalence range of 2.4% to 40.2%. [7] Very few studies have been carried out on MIH in the West zone of India. Hence, this study was undertaken in Pune to know the prevalence of MIH and caries associated with MIH along with the tooth affected , type and severity of defect .

Material and methods: A cross-sectional epidemiological study was conducted between July – September 2014 amongst fourteen hundred government school children aged 8 to 11 years in Pune, Maharashtra. Convenience sampling technique was used as there was population homogeneity. The study was conducted amongst six government schools in Pune to cover the sample size. Pune city was divided into four zones - East, West, North and South. Six schools from the west zone of Pune were selected according to convenience to cover a sample size of 1400 children. Based on the previous data available, the prevalence of MIH was considered to be 21.8%. [8] Sample size was calculated at 95% confidence interval using the formula $4pq/e^2$ for descriptive studies. A sample size of 1378 was obtained which was rounded upto 1400.

Prior to initiating the study, the chief investigator was trained and calibrated in the Department of Public Health Dentistry, of the Dental college and Hospital for the standardization of the criteria for the clinical assessment of MIH in the field. Clinical pictures of twelve patients (6 cases of MIH and 6 cases of other enamel defects) were used for the photographic calibration exercise. All the cases were diagnosed correctly. Confirmation regarding the use of clinical photographs for the purpose of validity to study enamel defects has been already established.[9] Clinical calibration was conducted where the inter-examiner reliability was tested for the diagnosis of MIH, its severity and MIH-C. Good agreement was seen with diagnosis of MIH [weighted kappa =0.8], for grading the severity of MIH [weighted kappa = 0.7] and for MIH-C [kappa =0.8]. Five subjects were re-examined after 30minutes for the purpose of reliability in the diagnosis of MIH, its severity and MIH-C. Good agreement was seen with diagnosis of MIH [weighted kappa = 0.8] for grading the severity of MIH [kappa =0.7] and for MIH-C [kappa =0.9].Also, duplicate examination was done among 150 subjects during the course of the study and the intra-examiner reliability (Kappa and weighted Kappa value) was found to be in the range of 0.8-1.0.

Ethical clearance was obtained from the institutional review and ethical committee of Dental College and Hospital. Participation in the study was sought from the parent of each student after obtaining a written informed consent.

The demographic details of the participants were collected. Oral examination was conducted in daylight conditions using a portable penlight torch by the chief investigator according to type III clinical

examination. The criteria given by the European Academy of Pediatric Dentistry (EAPD)[3] was used for the assessment of MIH. The severity of MIH was also assessed. [10,11] Caries associated with MIH (MIH-C)[12] was also recorded as per the WHO criteria,1997[13] for caries detection.

Diagnostic Criteria for MIH –

1.	Demarcated opacities
2.	Posteruptive enamel breakdown (PEB)
3.	Atypical restorations
4.	Extracted molars due to MIH
5.	Unerupted molar or incisor

Severity criteria for MIH –

Mild MIH	Demarcated enamel opacities without enamel breakdown, occasional sensitivity to external stimuli e.g. air/water but not brushing and only mild aesthetic concerns on discolouration of the incisors.
Severe MIH	Demarcated enamel opacities with breakdown, caries, persistent/spontaneous hypersensitivity affecting function e.g. during brushing and finally strong aesthetic concerns that may have socio-psychological impact.

Statistical Analysis: Descriptive statistics were calculated using IBM SPSS version 16. Pearson's chi square test was used for analysis of gender-wise and age-wise distribution of MIH and for gender-wise distribution of severity of MIH. Spearman's correlation was used to associate the age related severity of MIH. *P*-value of ≤ 0.05 was set as statistically significant.

Results: A total of 1400 children between the ages of 8 to 11 years were examined out of which 690 were girls (49.3%) and 710 boys (50.7%). The number of children examined in each group was almost equal, i.e, 344, 353, 358, 345 children at 8,9,10,11 years of age respectively.

Prevalence – Out of 1400 children examined, the prevalence of MIH was found to be 7.4% (103) and of MIH-C was 2.2% (31). The prevalence of MIH-C amongst the diagnosed MIH cases was found to be 30.1%.

Gender wise distribution of MIH – Out of 103 MIH cases,55 girls (53.40%) and 48 boys (46.60%) were found to be affected with no statistically significant difference between boys and girls affected with MIH. (Using chi-square test) (*P=0.386*)

Age wise distribution of MIH - MIH was found to be present at all ages. Maximum number of cases were found at 11 years (39.81%) and least number of cases at 8 years (11.65%). There was statistically significant difference between different age groups presenting with MIH.(Using Chi-square test)*(P=0.0)*

Tooth affected with MIH – Distribution of molars affected with MIH- 186 molars and 80 incisors, involving 266 teeth, were affected with MIH. The most commonly affected molar was mandibular right first permanent molar (FPM) (34.40%) and the least affected molar was maxillary right FPM (16.67%). Mandibular molars (58.06%) were found to be more affected with MIH than the maxillary molars (41.94%).

Distribution of incisors affected with MIH- The most commonly affected incisor was maxillary right central incisor (45%) and the least affected incisor was maxillary left lateral incisor (1.25%). Maxillary incisors (83.75%) were more affected than the mandibular incisors (16.25%).

Overall, maxillary teeth (54.51%) were more affected than the mandibular teeth (45.49%).

Combinations of MIH commonly seen – Out of 103 cases of MIH, molar hypomineralization (MH) was found in 36.89% cases and MIH was seen in 63.10% cases. Different combinations of affected teeth were seen. The combination most commonly

seen was of two molars and one incisor affected (40.78%) followed by 19.42% cases where only two molars were affected. Only two cases (1.94%) were seen where all four molars were affected and the least seen combination was where all the four molars and four incisors were affected which was found in a single case only (0.97%).(Table 1)

Type of defect –The type of defects most commonly seen were the demarcated opacities (94.09%) in molars followed by PEB (5.91%) whereas the other types of defects were not found. Among the incisors, all the 80 incisors affected with MIH showed demarcated opacities only.

Severity of defect – Most of the cases were affected with mild MIH (59.22%) and only 40.78% were severely affected. Thirty three girls and twenty eight boys had mild MIH whereas twenty two girls and twenty boys had severe MIH. Both MIH-C and PEB were considered to be severe defects. More number of cases affected with MIH-C (73.80%) were seen than PEB (26.20%).There was no statistically significant difference amongst boys and girls affected and the severity of MIH.(Using Chi-square test)*(P=0.67)*(Table 2)

Only molars were severely affected. The most severely affected tooth was maxillary right FPM (30.95%). The maxillary molars (52.38%) were more severely affected than mandibular molars (47.62%). All incisors presented with mild defects.

Also, it was found that, older the age, higher was the severity of MIH. More number of severely affected

teeth were found at 11 years (57.14%) than at 10 years (28.57%) and 9 years (14.29%) respectively. None of the teeth was severely affected in the 8 year age group. Thus, the severity of MIH increased with an increase in age of the children which was found to be statistically significant. (Spearman's Correlation value=0.122)*(P=0.0)*(Table 3)

Discussion: The study was conducted amongst government school children in Pune using the convenience sampling technique to cover a sample size of fourteen hundred children. The school children belonged to a similar socioeconomic and cultural background.

An age group of 8 years and above has been recommended by EAPD as by this age all four FPMs and majority of incisors erupt, hence, 8 to 11 years old children were examined in the present study.

The use of different diagnostic criteria such as Developmental Defects of Enamel (DDE) Index, Enamel Defects Index (EDI) by various authors made it difficult to compare the prevalence figures initiating the need to develop a standardized criteria for diagnosing MIH. Hence, a diagnostic criteria was formulated by European Academy of Pediatric Dentistry (EAPD) in 2003[3] which has been used in this study thereby making the results representative and comparable to other studies.

A prevalence of MIH of 7.4% was observed among 8 to 11 years old government school children in Pune. It is comparable to another study conducted amongst 8 to 12 years old Gujarati children (9.2%) [14],6 to 9 years old Chandigarh children (6.31%) [15] and 8 to 13 years old Udaipur children (9.46%) [16] in India. Similar prevalence was recorded amongst the Turkish children (7.7%) [17] and Lithuanian children (9.7%) [10] using the same diagnostic criteria. A higher prevalence was found in Spanish (21.8%) [8], Iranian (20.2%) [18], Brazilian (40.2%) [19] and Jordanian (17.6%) [20] children. The variations in the prevalence may be attributed to age groups selected (7 to 15 years), sample size and differing prenatal and postnatal care taken in the study regions.

Boys and girls showed a prevalence of MIH which was alike to the findings reported in Turkey [17], Brazil [19] and Spain. [8] Gender predilection was evident in other studies conducted in Jordan [20],Iran [18] where girls

were more affected than boys which has been attributed to faster dental development amongst girls than boys. Contrasting to this, prevalence amongst boys was found to be greater in Gujarati [14] population and Udaipur [16] children, however, it was not statistically significant.

Molar Hypomineralization (MH) and Molar Incisor Hypomineralization (MIH) form the "MIH Spectrum" where MIH affecting the FPMs only was considered to be a milder form of hypomineralization. [20] More number of teeth get affected as the severity and/or duration of the precipitating conditions increase. Thus, MIH (63.10%) was more evident than MH in this study and these results were comparable to Gujarati [14] population. Higher MH prevalence has been found in Udaipur [16] children and Jordanian [20] population. The present study found hypomineralization to be more prevalent amongst mandibular molars than maxillary molars which was comparable with studies conducted amongst the Gujarati [14], Udaipur [16], Jordanian [20] and Lithuanian [10] children. Similar distribution between the arches was recorded in Dutch [21] population, Hong Kong Chinese [22] and Turkish [17] children. More maxillary molars were found to be affected in German [23], Bosnian [24], Greek [25], Iraqi [26] population.The exact reason for susceptibility amongst maxillary and mandibular teeth is not known. However, it may be suggested that better lighting, visibility, sitting position during examination may lead to estimation of a higher prevalence in the mandible than maxilla. However, the examiner was well trained and calibrated. So, it could also be attributed to the early eruption of mandibular molars resulting in early post-eruptive enamel breakdown and caries making them more obviously affected [27]. Amongst incisors, higher prevalence was recorded in maxillary incisors suggesting the results to be comparable with Gujarati [14], Udaipur [16], Lithuanian [10], Hong Kong Chinese [22], Greek [25] and Iraqi [26] populations. Contrasting findings were recorded in Jordanian [20] and Turkish [17] children.

The enamel formation and maturation of FPMs begin at birth and gets completed during second or third year of life. The enamel formation for incisors begins at the third or fourth month of life and gets completed by 4 to 5 years of age. Any insult or insults in the form of childhood illnesses, infections and malnutrition during this critical period affects these teeth more than other teeth which develop later thereby resulting in MH or MIH .[28]

In this study, the combinations of MIH seen included 2 molars/1 incisor, 2 molars,1 molar, 2 molars/2 incisors,1 molar/1 incisor, 4 molars, 4 molars/4 incisors. The combination most commonly seen was that of 2 molars/1 incisor while least commonly reported was 4 molars/4 incisors. The combination most commonly found among Greek [25] children was 4 molars/2 incisors followed by 4 molars/4 incisors and least commonly reported was 2 molars alone.

Thus, an insult of increased severity and/or longer duration may affect both molars and incisors resulting in such combinations indicating the time of occurrence and severity of the insult. [20]

The enamel of MIH affected teeth have a decreased Ca:P ratio with increased carbon content and mineral density to be 19% lower than sound enamel. The enamel becomes more porous thereby allowing easy penetration of bacteria into the dentinal tubules thereby making the teeth more prone to caries .[29,30,31] Thus, the term MIH-C was explained by Alaluusua [12] in 2012 after Caufield [32] proposed a similar entity of HAS-ECC (Hypoplasia associated severe Early Childhood Caries) in the primary dentition. Prevalence of MIH-C in this study was found to be 2.2% and 30.1% amongst the diagnosed cases of MIH or MH. Higher caries experience was noted amongst children with MIH in most of the publications in a systematic review. [33] The contribution to the global prevalence of

MIH was due to the significant number of cases reported in heavily populated countries, whereas, countries like India contributed more to the incident cases. [34]

Mild defects included only demarcated opacities without enamel breakdown whereas severe defects consisted of demarcated opacities with post eruptive enamel breakdown (PEB), caries and spontaneous hypersensitivity affecting function. [10] MIH affected teeth undergo PEB when subjected to masticatory forces. Both PEB and MIH-C affected teeth have been considered to be severely affected in the present study (Figure 1 and 2).

Mild MIH was more common than severe MIH in this study as found in the Gujarati [14], Jordanian [20], German [23] and Lithuanian [10] population. Mild defects were more commonly seen than severe defects in molars whereas only mild defects were seen amongst incisors. It may be suggested that the hypomineralization defects being present on the labial surfaces of incisors may not have been subjected to masticatory forces resulting into mild defects only. Also, it was found that the severity of MIH increases with an increase in age as reported in the Gujarati [14], Turkish [17], Jordanian [20] and Lithuanian (Kaunas) [10] population. Thus, the severity would increase with an increase in age as the susceptibility of the teeth to caries attack and PEB occurring due to masticatory forces increase with the advancement of age. [10]

Early diagnosis is imperative to initiate preventive treatment at an early stage. Preventive guidelines need to be formulated for the mothers, dentists, gynecologists, pediatricians to impart education about adequate prenatal, perinatal, postnatal care to prevent MIH. Curative treatment options for the existing decayed lesions include restoration with glass ionomer cement, composites, pulp therapy with crowns or extraction of the tooth depending upon the severity of the carious lesion. The sample represents those belonging to the lower socio economic strata and hence the results cannot be generalized.

Conclusion: This study adds new data about prevalence of MIH to National and International records.The prevalence of MIH and MIH-C amongst government school children in a city in Maharashtra, India was recorded as 7.4% and 2.2% respectively with no evident gender predilection. MIH was found to be more common than MH. More number of mandibular molars and maxillary central incisors presented with the defect. Mild MIH was more common than severe MIH. However, higher the age, the severity of the defect worsened.

Recommendations: Preventive guidelines need to be formulated for the mothers, dentists, gynaecologists, pediatricians to impart education about adequate prenatal, perinatal, postnatal care to prevent MIH. Further studies are recommended using EAPD 2003 criteria for better comparison of results. Future studies comparing prevalence of MIH in rural and urban population, in high fluoride concentration areas need to be carried out. Also, studies on the colour of MIH defects and MIH in different socioeconomic classes are recommended.

Study limitations: Non probability sampling technique and cross sectional study design was used. Further longitudinal studies using probability technique are needed to confirm the etiology and characteristics of MIH**.**

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Table 1 - Combinations of Molar Incisor Hypomineralization

Combination	2M/ 1I	2M	1M	2M/ 2I	1M/ 1I	4M	4M/ 4I
Number of cases	42	20	16	12	10	02	01
Percentage of cases(%)	40.78	19.42	15.53	11.65	9.71	1.94	0.97

M – Molars , I – Incisors

Table 2– Severity of Molar Incisor Hypomineralization

Gender	Mild	Severe			Total number of cases
		MIH-C		PEB	
Male	28	13	07		48
Female	33	18	04		55
Total	61 (59.22%)	31	11	42(40.78%)	103

Chi-square (Asymp sig) (2 sided) = 0.677 *(P>0.05)*

Figure 1 - Mild MIH (demarcated opacities)

Table 3 – Age wise distribution of severity of Molar Incisor Hypomineralization

Age	No defect	Mild MIH	Severe MIH	Total
8 years	332 (96.5%)	12 (3.5%)	0	344
9 years	333 (94.3%)	14 (4%)	06 (1.7%)	353
10 years	328 (91.6%)	18 (5%)	12 (3.4%)	358
11 years	304 (88.1%)	17 (4.9%)	24 (7%)	345
Total	1297 (92.6%)	61 (4.4%)	42 (3%)	1400

Significant (2-tailed) = 0.0, correlation is significant at 0.01 level , Spearman's Correlation Value = 0.122

Figure 2 - Severe MIH (caries associated with MIH – MIH-C)

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