RESEARCH ARTICLE

Molar Incisor Hypomineralization: Prevalence, Associated Risk Factors, Its Relation with Dental Caries and Various Enamel Surface Defects in 8–16-year-old Schoolchildren of Lucknow District

Sarita Verma[1], Kavita Dhinsa[2], Abhay Mani Tripathi[3], Sonali Saha[4], Gunjan Yadav[5], Deval Arora[6]

Abstract

Introduction: The decreased rate in dental caries cases across the world has created an enthusiasm in many clinicians to relate and study different developmental disorders. In past years, defects that are commonly associated with dentistry are hypomineralized areas commonly seen in central incisors and first molars. Molar incisor hypomineralization (MIH) is a defect of the enamel, which is qualitative in nature and systemic in origin characterized by advanced and concurrent hypomineralization of the enamel affecting the first permanent molars together with frequent association of the incisors.

Aim: To evaluate the prevalence of molar incisor hypomineralization (MIH), its possible risk factors and its association with dental caries and enamel surface defects (attrition and abrasion) in schoolchildren aged between 8 and 16 years in Lucknow district.

Methodology: Indexed teeth (first permanent molars and incisors) of 5,585 schoolchildren, selected by stratified random sampling technique between the age-group of 8 and 16 years, were examined by a trained and calibrated examiner. The data was recorded in a predesigned pro forma by examiner, which consisted of mainly two parts. The first part comprised of general information, while the second part comprised of questions related to risk factors related to MIH (prenatal, perinatal, and postnatal history). For the diagnosis of MIH, the Developmental Defects of Enamel (DDE) Index was used for diagnosis of MIH, while the decay-missing-filled teeth index (DMFT) criteria were used for assessing dental caries. Enamel surface defects were recorded using the Smith and Knight tooth wear index.

Results: A prevalence of 7.6% was reported wherein females were found to be more affected by MIH. A strong significant correlation was found between MIH prevalence and childhood infection.

Conclusion: Early diagnosis of MIH is necessary to prevent the rapid destruction of the tooth morphology resulting in complicated treatment. Further studies with greater samples are needed to investigate the different etiological factors and determine the biological molecular mechanism that they may cause.

Clinical significance: The data obtained from the current study does not portray a clear consideration of the infants' medical history in the initial 4 years of life. Further studies may be performed to surpass these shortcomings by using more elaborate medical records of the child in addition to profound recollection of the parents. Due to paucity of literature on this issue in Lucknow District, our current study may provide some information at a baseline level for conducting an extensive research involving different regions pan-India.

Keywords: Dental caries, Enamel surface defects, MIH, Schoolchildren

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Introduction

One of the most common problems associated with Indian population is dental caries. In the past many years, due to decrease in prevalence rate of dental caries, the mind of researchers has moved on to other nonfluoridated lesions affecting the teeth.[1] Most commonly involved dental defect is hypomineralized enamel affecting the molars and incisors.[2]

In 2001, Weerheijm et al. coined the term molar incisor hypomineralization (MIH), although it was initially observed in Sweden in the later-half of 1970.[3] According to Weerheijm et al., MIH is a systematically originated hypomineralized defect due to disruption of ameloblast cells in their maturational stage.[4]

Across the globe, this defect has the highest prevalence in Brazil ranging from 2.4 to 40.2%. The prevalence differences throughout the world may be due to difference in method of assessing the defects along with differences seen in religion and caste.[5] The prevalence rate in other in South East Asian countries showed a variation from 9.25 to 20.2%.[6]

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Due to paucity of literature in regards to this ectodermal defect, the various clinical findings additionally may lead to several

undiagnosed cases thereby creating a biased diagnosis affecting the treatment modalities.[7]

It becomes imperative to investigate the susceptibility of these MIH children to an increased incidence of dental caries and enamel surface defects.[8] Hence, the aim of the present study was to determine the prevalence of MIH and study its association with dental caries and enamel surface defects in school children aged 8–16 years of Lucknow district.

Materials and Methodology

This present cross-sectional study was carried out in the Department of Pedodontics and Preventive Dentistry at Sardar Patel Post Graduate Institute of Dental and Medical Sciences, Lucknow collaborating with Government and Private schools of Lucknow city to assess the prevalence of MIH, evaluate the possible etiological factors associated with MIH, its relation with dental caries, and various enamel surface defects. Written consent from parents, concerned authorities of schools were sought prior to start of the study in their local regional language. The research project was initiated after the approval of institutional ethical clearance. The diagnostic instruments were sterilized by autoclave at a temperature of 121°C for 15 minutes at 15 psi pressure in the Department itself before going for the collection of data. The presterilized instrument was properly packed and carried to the school in instrument drums along with disposable masks and gloves to be used by investigator during examination (Fig. 1).

The clinical examination of the subjects was conducted on an ordinary chair with high backrest and position of the examiner sitting in front of the chair pertaining to examine variables (Fig. 2). The examination was performed under natural light. Children were examined in the school premises for the prevalence of MIH. These MIH children along with their mother were interviewed for a complete prenatal, perinatal, and postnatal history (Fig. 3).

Taking into account the possible restrains/limitations of the main study, previously a pilot study was carried out. A total of 5,585 school children between the age group of 8 and 16 years were selected by using stratified random sampling technique to get an equal distribution of children by socioeconomic strata and gender. The whole of Lucknow district was split into South, North, West, and East zone, respectively. From each zone, we selected two schools, thus comprising of eight schools from the city.

Fig. 1: Material and armamentarium used in the study

Inclusion Criteria

- Subjects present at the day of examination.
- Children whose parents agreeing for their child's participation.
- Children with completely erupted incisors and first permanent molars.

Exclusion Criteria

- Subjects with developmental imperfection such as enamel hypoplasia, amelogenesis imperfecta, dentinogenesis imperfecta, or dental fluorosis.
- Children undergoing orthodontic treatment and wearing fixed appliances at the moment of assessment, which would interfere with evaluation of index teeth.
- Children showing erosion as enamel surface defects, as it is chemically induced.
- Children with fractured or root canal treated permanent incisors and molars.
- Children with any restoration in their first permanent molars and incisors.

The DDE (Developmental Defects of Enamel) Index by Clarkson and O'Mullane (1989) was used for the diagnosis of MIH presence. This was based on the guidelines given by the European Academy of Pediatric Dentistry (Weerheijm et al.) 2003.

Fig. 2: Intraoral examination of children

Fig. 3: Filling of the questionnaire by the mothers of molar-incisor hypomineralization (MIH)—positive children

In DDE index, there were three types of opacities:

- *Demarcated opacity*: These are yellow, creamish, or brown color areas of normal thickness of intact enamel with alteration in translucency.
- *Diffuse opacity*: In this, there is no clear boundary, opacity can be linear or patchy or confluent distribution, white in color.
- *Hypoplasia*: There is localized reduction in thickness of enamel or pits and grooves. There may be an area of partial or total loss of enamel too.

The association by Klein, Palmer, and Knutson's DMF (Decayed-Missing-Filled) Index given in the year 1938, which was modified by WHO (1987). Apart from dental caries, a strong association of MIH can be seen with enamel defects, which was recorded using Smith and Knight tooth wear index (1984). All the data was calculated and sent for statistical analysis.

Results

A total of 5,585 schoolchildren aged between 8 and 16 years were examined out of which 2,794 were males and 2,791 were females. The prevalence of MIH was found to be 7.6% (Table 1 and Fig. 1). Females showed slightly higher predilection for MIH as compared to males with 7.8% of females being affected as compared to 7.5% of males (Table 2 and Fig. 2). A total of 2,424 teeth were examined out of which 1,457 maxillary teeth and 967 mandibular teeth were affected showing a higher predilection in maxillary teeth as compared to mandibular teeth. Maximum prevalence was seen at a peak age of 10 years. The mean age of children affected with MIH was between 10 and 11 years. Demarcated opacities (5.6%) were the most common type of MIH as compared to all other types of MIH.

Among the prenatal factors, mother's illness and infections (52.5%) (Table 3 and Fig. 3) and intake of medications (55.7%) during pregnancy were significantly associated with MIH as compared to all other maternally influenced factors. Among all perinatal factors, type of delivery (58.5%) (Table 4 and Fig. 4) was found to have a strong association with MIH.

Among the post-natal factors, childhood illness (50.8%) (Table 5 and Fig. 5) and the intake of medication (30.7%) by child in initial 4 years of life. Higher incidence of dental caries and enamel surface defects was observed in children associated with MIH stating a positive correlation between dental caries, enamel surface defects, and MIH.

Table 1: Prevalence of molar-incisor hypomineralization (MIH)

MIH	*Frequency*	*Percent*
Absent	5,158	92.4%
Present	427	7.6%
Total	5,585	100.0%

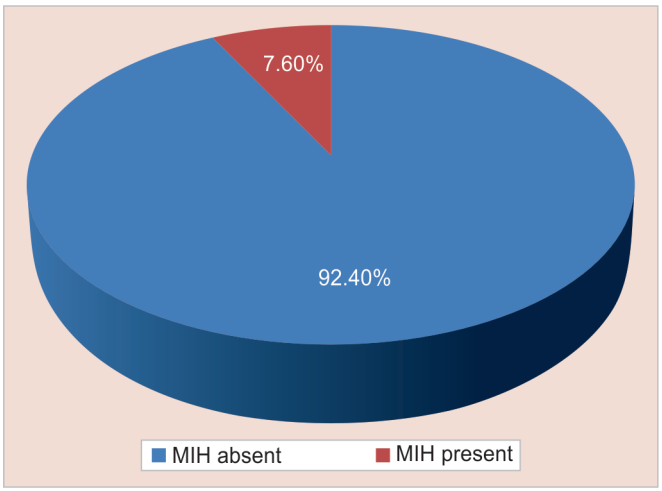

Fig. 1: Prevalence of molar-incisor hypomineralization (MIH)

Discussion

The goal of this cross-sectional study was aimed to evaluate the MIH prevalence in school children aged 8–16 years of Lucknow district. The worldwide prevalence of MIH ranges from 2.4 to 40.2%. European countries show a prevalence of MIH ranges from 3.6 to 37.5%.[6]

The prevalence rate reported in our study was 7.6%, which was lower as compared to that found in other studies by Kirthiga et al. (2017),[9] Hanan et al. (2015),[10] Ravindran and Saji (2016),[11] Yannam et al. (2016),[3] and Padavala and Sukumaran (2018)[12] with prevalence of 8.9%, 9.12%, 32%, 9.7%, and 12.9%, respectively. The prevalence of MIH was found to be 9.4% in Udaipur,[5] 9.2% in Gujarat,[13] and 27% in Udupi.[6]

This variation noted in prevalence rate could be due to dissimilarities in age group chosen, cultural diversities, and method chosen for diagnosis, which may affect the routine of mothers in day-to-day life.[14]

In the guidelines laid down by European Academy of Pediatric Dentistry (EAPD), the status of erupting index teeth during examination has not been included, even though this is a very important imperative factor when prevalence rates are compared.[15] The modified DDE index was followed in the present study to attain more confirmatory results after examination of children in older age groups, wherein there is full eruption of indexed teeth at the time of diagnosis.[15] The difference in the rates of prevalence in comparable middle eastern studies and our current study can be explained by the status of tooth eruption.[5] The verifiable MIH prevalence is often masked by the existence of dental caries and when it is studied for children with older age-group, we may encounter superimposition of the restorations and occlusal wear with the defects caused during development. The age at which children are prone to MIH should be identified so that preventive measures can be directed to protect the risk population to considerable extent. The observation of the current study stated that peak age prone for MIH is 10 years. The mean age of children affected with MIH was between 10 and 11 years. This could be ascribed to the fact that in children during this age, weakened hypomineralized tooth structure has been exposed to masticatory and other stresses for a longer time period.[16] Earlier and easier diagnosis in discolored posteruptive mild defects shows an increased risk of MIH in older children, which may not be noticeable in younger age group children.[5]

210 (7.51%) boys and 217 (7.77%) girls were affected with MIH in the current study out of 427 children affected MIH children. Our findings were in accordance with the earlier studies conducted. The discrepancies in sequential development of teeth result in higher prevalence of MIH in females.[17-20] Also, it could be due to variation in oral care and behavior.[15] In addition, Rai et al. (2018) stated that females have higher advanced dental development in comparison to males exposing the permanent molars to forces of mastication ultimately resulting in posteruptive destruction in comparison to males of similar age groups.[14]

Table 2: Age-wise prevalence of molar-incisor hypomineralization (MIH)

			MIH		*Total*
			Present	*Absent*	
Age	8	N	54	621	675
		%	8.0%	92.0%	100.0%
	9	N	131	644	775
		%	16.9%	83.1%	100.0%
	10	N	200	674	874
		%	22.9%	77.1%	100.0%
	11	N	8	582	590
		%	1.4%	98.6%	100.0%
	12	N	6	464	470
		%	1.3%	98.7%	100.0%
	13	N	7	554	561
		%	1.2%	98.8%	100.0%
	14	N	8	642	650
		%	1.2%	98.8%	100.0%
	15	N	7	514	521
		%	1.3%	98.7%	100.0%
	16	N	6	463	469
		%	1.3%	98.7%	100.0%
Total		N	427	5,158	5,585
		%	7.6%	92.4%	100.0%
P value			<0.0001, S		

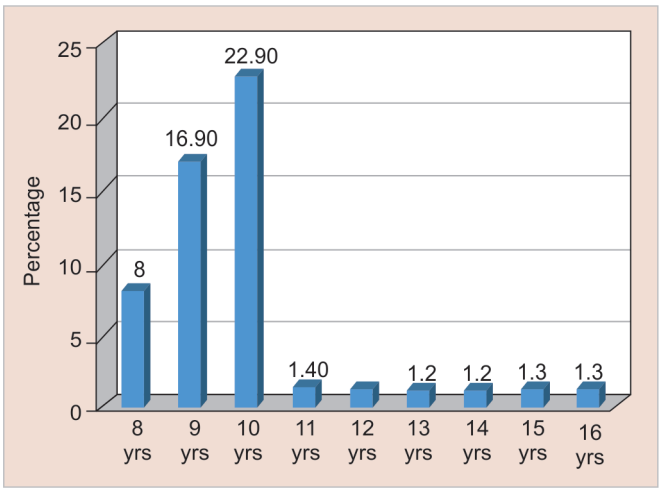

Fig. 2: Age-wise prevalence of molar-incisor hypomineralization (MIH)

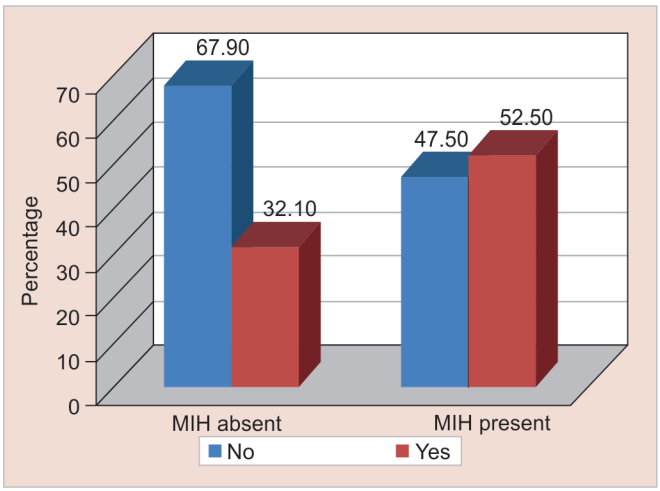

Fig. 3: Association of infection of mother during pregnancy with molar-incisor hypomineralization (MIH)

Table 3: Association of infection of mother during pregnancy with molar-incisor hypomineralization (MIH)

			Infection in pregnancy		*Total*
			No	Yes	
MIH	Absent	N	3,504	1,654	5,158
		%	67.9%	32.1%	100.0%
	Present	N	203	224	427
		%	47.5%	52.5%	100.0%
Total		N	3,707	1,878	5,585
		%	66.4%	33.6%	100.0%
P value				<0.0001, S	

Table 4: Association of type of delivery with molar-incisor hypomineralization (MIH)

			Type of delivery		*Total*
			Normal	*Cesarean*	
MIH	Absent	N	3,229	1,897	5,126
		%	63.0%	37.0%	100.0%
	Present	N	177	250	427
		%	41.5%	58.5%	100.0%
Total		N	3,406	2,147	5,553
		%	61.3%	38.7%	100.0%
P value				0.002, S	

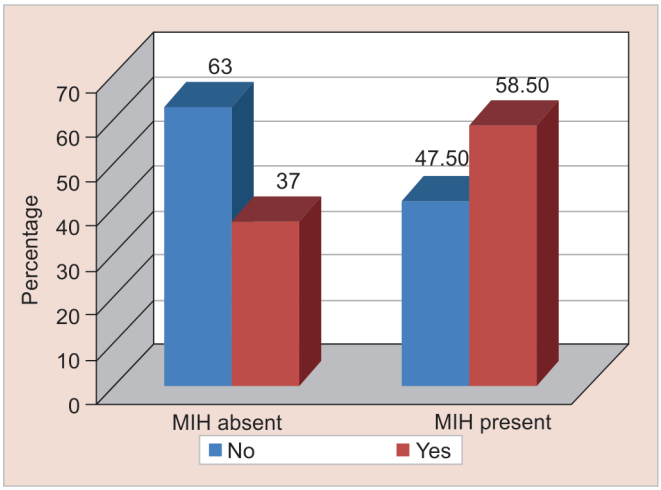

Fig. 4: Association of type of delivery with molar-incisor hypomineralization (MIH)

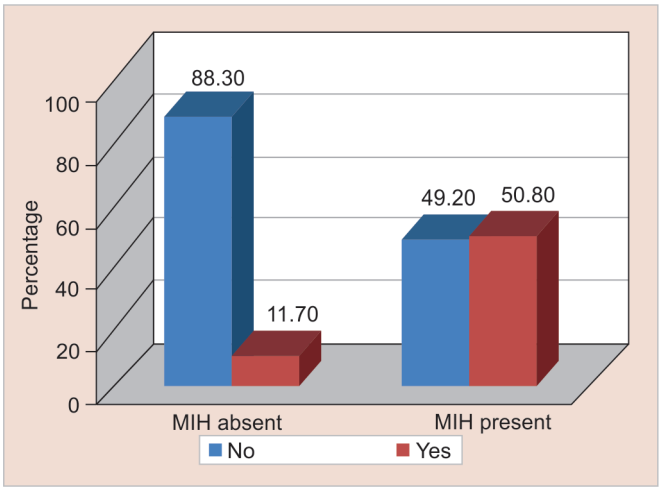

Fig. 5: Association of childhood illness and molar-incisor

Table 5: Association of childhood illness and molar-incisor hypomineralization (MIH)

			Childhood illness		*Total*
			No	*Yes*	
MIH	Absent	N	4,523	597	5,120
		%	88.3%	11.7%	100.0%
	Present	N	210	217	427
		%	49.2%	50.8%	100.0%
Total		N	4,733	814	5,547
		%	85.3%	14.7%	100.0%
P value				<0.0001, S	

In the present study, examination was conducted in children belonging to all socioeconomic strata. Additionally, the family income and education level of fathers were used for grading the socioeconomic status. In the current study, majority of study samples affected were deprived of health care access, childhood diet, and the environment where the child resides.[15]

Of all 2,424 teeth were affected the maxillary number were the incisors and molars of upper arch in comparison to lower teeth. This is in agreement to studies previously by Leppaniemi et al. (2001)[21] and Makne et al. (2017).[22]

For diagnosis of MIH, the DDE (Modified Developmental Defects of Enamel Index (Clarkson and O'Mullane, 1989) was used in present study based on the guidelines issued by the European Academy of Pediatric Dentistry 2003. The primary factor recorded in the index is the opacity demarcation (diffused/demarcated) rather than its color. Hence, a single scoring criterion is applied to every recorded defect instead of two scores.[23]

Demarcated opacities (5.6%) were the most frequent type of MIH recorded in the present study. This finding was in agreement with Robles et al. (2013).[24] According to them, damaging effects to the ameloblast cause demarcated defects in the beginning to terminal maturation phase, but this is of transient origin because the ameloblast cells are able to recuperate their usual functions.[24] The possible clarification for the resultant demarcated opacities could be due to a sudden disturbance to the ameloblast during their maturation phase or a slighter long-lasting difference during the ameloblast secretory phase. On the other hand, the diffuse opacities are resultant of less severe assault occurring during the secretory/postsecretory phases, ultimately resulting in a retarded mineralization of ameloblasts.[25]

Molar incisor hypomineralization is manifested clinically as a clear opacity of the enamel due to systemic insults that take place during amelogenesis in the maturation phase.[2] The etiology of these lesions is not clear and can vary from prenatal, natal, and postnatal causes.[22] The cause of MIH can be due to impaired mineralization of the permanent first molars and incisors.[26] In the current study, a profound similarity was noted during all stages of infections, i.e., prenatal, perinatal, and postnatal periods.

Prenatal Medical Conditions

In the present research, MIH was remarkably more frequently found in mothers who previously experienced medical issues in their prenatal phase such as illness or infection, use of medication and antibiotics, maternal diabetes, and maternal hypertension in the late gestational weeks.

In the present study, MIH was significantly associated with mother's illness or infections and intake of medications during pregnancy which is in accordance with the previous studies conducted by various authors.[27,20,14]

As stated by Norwitz et al. (1999),[28] use of adrenergic antagonists during gestation might result in side effects such as vomiting, maternal nausea, fetal hypocalcemia, and biochemical disturbances, which in turn can lead to MIH. Also, Nelson–Piercy (1998)[29] stated that prolonged vomiting by mother due to medication in the last gestational days can result in neonatal hypoxia, which can hamper the formation of ameloblast thereby resulting in MIH.[27]

Perinatal Medical Conditions

Various medical problems such as complications during birth, premature labor, low-birth weight, prolonged labor, and the type of delivery have some adverse effects in the perinatal period, which may have some effects on the well-being of the child. These complications resulted in ameloblast dysfunctioning due to low level of oxygen levels during birth.[27]

In the present study, MIH was found to be significantly associated with the type of delivery, with 58.5% mothers having the history of cesarean delivery. This study is concurrent with the results of Hansen et al. (2008),[30] wherein authors found that children delivered by cesarean section when compared to natural child birth infants were more prone to respiratory disorders accompanied by medical conditions related to hypoxia. Induction of spinal anesthesia used during cesarean section delivery is associated with hypotension of mothers, which presents as a very common obstacle leading to hypoxia in infants.[27]

Postnatal Medical Conditions

Considerable importance has been given to chronic childhood diseases, long-lasting fevers caused by infections, use of antibiotics such as amoxicillin, and exposure to toxins of the environment. Various infections of upper respiratory tract infections (e.g., asthma, pneumonia, and bronchitis), urinary tract and exanthematous diseases (measles, rubella, and chickenpox) have been found to be strongly correlated with MIH. Most frequently, celiac disease has been associated with the presence of defects in enamel.[31]

In our study, a significant correlation was evident between MIH and illness in the early childhood years. Similar results were found in studies conducted by Jalevik (2001)[32] and Muratbegovic et al. (2007)[33] who stated that MIH was an important finding among children who had suffered from childhood diseases such as otitis media, asthma, and upper respiratory tract infections.[7,34] In a similar study by Beentjes et al. (2002),[35] it was found that children suffering from otitis media, and pneumonia-like conditions and presenting high-grade fever during early childhood were more likely to infest MIH.

The relationship between MIH and fever is undefined. Ameloblasts seem to be highly sensitive to relatively small changes occurring in their environment. Hyperthermia, hypocalcemia, and pH alterations can cause disarray in the normal amelogenesis process.[34]

Molar incisor hypomineralization was also found to be associated with ear infection, tonsillitis, and allergies in the early childhood years, which is in accordance with the similar studies reported earlier by Allazzam et al. (2014)[34] and Mishra and Pandey (2016).[20]

Molar incisor hypomineralization was also found to be associated with asthma and intake of asthma medications in the early childhood years. Similar results were obtained by Shubha and Hegde (2013),[31] Allazzam et al. (2014),[34] and Koruyucu et al. (2018)[36] in their studies. Asthmatic conditions can have damaging effects on the activity of ameloblasts during the mineralization of enamel due to direct effects of the disease or due to hypocalcemia, hypoxia, or fever.[34] It has been noted that various conditions that effect the pH of the enamel matrix have an inhibiting action on the proteolytic enzymes resulting in hypomineralization of the enamel.[37,38,34]

Molar incisor hypomineralization was also found to be associated with antibiotic usage in their early childhood years, which is in congruence with various other studies.[39-43] As stated by Laisi et al. (2009),[44] antibiotics such as amoxicillin possibly interfere with the normal functioning of ameloblast and in turn stimulate amelogenesis initiation and enhance the rate of enamel deposit.[45] Also, in experimental studies, amoxicillin has been found to disturb the development of enamel.[46]

Molar incisor hypomineralization has been considered a risk factor for caries even in populations showing a low rate of caries prevalence whereas in high caries populations, carious lesions could camouflage the hypomineralized lesions. As stated by da Costa-Silva et al. (2010),[47] dental caries have a greater prevalence in MIH-affected individuals. Our study has also shown a strong correlation seen between dental caries and MIH. Dental caries are more prone to develop in defective surfaces of the enamel.[48] It has been found that MIH is linked to hypersensitivity of teeth together with structural weakness; hence, there always remains a high probability of poor oral hygiene maintenance leading to higher incidence of dental caries.[1]

Present study showed that enamel surface defects and dental caries have strong correlation with dental erosion. In a similar study conducted by Kazoullis et al. (2007),[49] the presence of surface enamel defects in same teeth having erosion proposing that the abnormal surface enamel maturation may be a causative factor for erosion of teeth. Alteration in mineralization content formerly seen in enamel surface defects can result in increased dissolution caused by acids and loss of secondary tooth structure.[49]

Increased cases of MIH have caused a threat to this type of enamel defect. Based on the cost expenditures together with low awareness among dentist, further investigations on this burning problem are the need of the hour. A thorough recall and follow-up of children suffering from MIH is of utmost importance along with creating awareness in the public and formulating preventive programs. There is a need to conduct a survey nationwide to evaluate the prevalence of MIH.

Conclusion

The MIH prevalence among 8–16 years aged school children of Lucknow district was found to be 7.6%. A slight female predilection was reported. Maximum prevalence was seen at a peak age of 10 years. Maxillary teeth showed a higher prevalence of MIH along with demarcated opacities compared to mandibular teeth. A positive correlation seen between cases of MIH and children residing in industrial area.

Among all prenatal factors, mother's illness and intake of medications during pregnancy were significantly associated with MIH as compared to all other maternally influenced factors. Among all perinatal factors, type of delivery was found to have a strong association with MIH. Among the postnatal factors, childhood illness and the intake of medication by infants in the initial 4 years of life have shown a strong positive association with MIH.

Dental caries and enamel defects were higher in children with MIH stating a positive correlation between MIH, dental caries, and enamel defects.

Clinical Significance

The data obtained from the current study does not portray a clear consideration of the infants' medical history in the initial 4 years of life. Further studies may be performed to surpass these shortcomings by using more elaborate medical records of the child in addition to profound recollection of the parents. Studies with greater sample size may elaborate the different etiological factors determining the different processes that cause detrimental effects to the ameloblasts. Due to paucity of literature on this issue in Lucknow District, our current study may provide some information at a baseline level for conducting an extensive research involving different regions pan India.

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