



Molar-Incisor Hypomineralization and Associated Factors: A Case-Control Study

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Abstract

Objective: To evaluate systemic factors those are related to molar incisor hypomineralization (MIH), its association with dental caries, and the impact on oral health-related quality of life (OHRQoL) in Brazilian children. **Material and Methods:** This case-control study was conducted at the Pediatric Dentistry Clinic, Federal University of Parana, Brazil. Patients with MIH who were assisted from 2014 to 2015 were included in the study, for a total of 31 children, 6-13 years of age. The control group consisted of 62 children who were matched by sex and age. European Academy of Pediatric Dentistry criteria were used for MIH diagnosis. The children's mothers answered a questionnaire regarding the children's history of health interurrences in the pre-, peri-, and postnatal periods. The Decayed, Missing, or Filled Teeth indices for permanent and primary teeth (dmft index and DMFT index, respectively) were used for dental caries examination by two calibrated examiners. Child Perceptions Questionnaires for 8- to 10-year-old children and 11- to 14-year-old children (CPQ₈₋₁₀ and CPQ₁₁₋₁₄) were used to assess OHRQoL. **Results:** Prematurity and prolonged delivery were significantly associated with the occurrence of MIH. In the postnatal period, recurrent fevers in the first 3 years of life were associated with MIH. Of the 339 incisors and first permanent molars that were examined, 178 presented MIH, of which 116 (65%) were demarcated opacities. A significant difference was found in the mean DMFT index between groups. No impact of MIH on OHRQoL was observed. **Conclusion:** The present results suggest higher interurrences during the perinatal period and a higher incidence of caries among children with MIH.

Keywords: Dental Enamel Hypoplasia; Child; Quality of Life; Dental Caries.

Introduction

Hypomineralization, also called opacities, is a qualitative defect of enamel development [1,2] that results from sudden and severe aggression to ameloblasts during amelogenesis [3,4]. Hypomineralization is clinically identified as abnormal translucency of the enamel, characterized by areas of white, cream, yellow, or brown color with a smooth surface and normal thickness [5]. When these lesions are of systemic origin and when they affect one or more permanent first molars, they are referred to as molar incisor hypomineralization (MIH) [5-7].

The prevalence of MIH varies from 2.4% [8] to 70% [9] around the world and from 2.5% [10], 12.3% [11] and 40.2% [12] in Brazil. Nonetheless, the etiology of MIH has not yet reached a consensus [2,3,13]. Respiratory diseases and perinatal complications (e.g., low birth weight associated with a lack of oxygen) may be associated with the occurrence of MIH [2,14,15]. Intercurrences during the first 3 years of life, such as recurrent fevers, respiratory problems, and infections, are associated with the presence of MIH [2,14,15].

Impairments of the mechanical properties of the enamel of teeth that are affected by MIH make these areas susceptible to post-eruptive collapse and other morbidities, such as dental caries [4,5,16,17]. This fact represents a challenge for the dental professional because it can lead to failures of restorations or, in more serious cases, extraction of the dental element [3,7,11,14,18,19].

Moreover, involvement of the incisors can lead to aesthetic compromise and increase the sensitivity of affected teeth [4]. A recent study correlated MIH with oral health-related quality of life (OHRQoL) in Brazilian adolescents (11-14 years of age) and found an inversely proportional association between MIH severity and OHRQoL [20].

The present case-control study evaluated systemic factors that are related to MIH, its association with dental caries, and the impact on OHRQoL in Brazilian children.

Material and Methods

Study Design

The case group consisted of all children with MIH who attended the Pediatric Dentistry Clinic, Federal University of Parana, Brazil, from 2014 to 2015. For each child in the case group, two children were selected for the control group (i.e., without MIH), who were matched by sex and age (\pm 60 days of age). For sample calculation, we assumed a proportion of systemic factor exposure in the case and control groups of 50% and 25%, respectively. Considering a significance level of 5% and the proportion of two controls per case, we estimated that a sample of 31 children in the case group and 62 children in the control group resulted in 80% power to estimate differences between groups.

The inclusion criteria included children with all first permanent molars fully erupted. Children with conditions that were associated with other types of enamel defects (i.e., not MIH), who were diagnosed with dental fluorosis, hypoplasia, or imperfect amelogenesis, or who were using fixed orthodontic appliances at the time of the examination were excluded from the study [21].

Data Collection

Systemic Factors

A questionnaire was completed by the children's mothers. Such information as the occurrence of high fever, malnutrition, and anemia during pregnancy were collected. Health interurrences during the perinatal period included delivery conditions, such as prematurity, the type of delivery (cesarean or natural), the duration of delivery (prolonged >14 h) [22], and other complications. In the postnatal period, interurrences were assessed up to the first 3 years of life, based on questions that included recurrent fevers, respiratory diseases, auditory canal infection, and the use of antibiotics.

Oral Health-Related Quality of Life

The impact of MIH on OHRQoL in the children was analyzed using the Child Perceptions Questionnaire for 8- to 10-year-old children (CPQ₈₋₁₀) [23] and 11-to 14-year-old children (CPQ₁₁₋₁₄) [24]. Children who were 6-7 years of age were excluded from this analysis. The CPQ₈₋₁₀ consists of 25 items that comprise four subscales: five items for oral symptoms, five items for functional limitations, five items for emotional well-being, and 10 items for social well-being. The items asked how often events occurred in the 4 weeks prior to the interview. The response options followed a 5-point scale: once = 0, once or twice = 1, sometimes = 2, often = 3, and every day or almost every day = 4. The children could have values on the instrument that ranged from 0 (no impact of their oral condition on their quality of life) to 100 (maximum impact of their oral condition on their quality of life). The instrument also has two items for patient identification (gender and age) and two general items about the child's oral health and the degree to which oral alterations affect the child's general well-being [23].

The CPQ₁₁₋₁₄ is structured as 37 items that are distributed into four subscales: oral symptoms (six questions), functional limitations (10 questions), emotional well-being (nine questions), and social well-being (12 questions). Similar to the CPQ₈₋₁₀, the response options followed a 5-point scale: once = 0, once or twice = 1, sometimes = 2, often = 3, and every day or almost every day = 4. The values could vary from 0 to 148. A higher score indicates a larger impact [24].

Clinical Data Collection

The clinical examination was performed by two previously calibrated examiners. The presence of MIH was first evaluated according to European Academic of Paediatric Dentistry (EAPD) criteria, including demarcated opacity, post-eruptive enamel breakdown, atypical restoration, and extraction due to MIH [5]. For this evaluation, intra- and inter-examiner agreement was $\kappa \geq 0.786$. Opacities were considered mild defects and divided into white, yellow, and brown. Post-eruptive enamel breakdown, atypical restorations, and extraction due to MIH were categorized as severe defects [11]. Lesions with a diameter >1.0 mm were considered [7], and the differential diagnosis for white-spot lesions was based in a previous study [25]. The World Health

Organization (WHO) criteria for dental caries was used [26] and the dental examination was performed by two calibrated investigators ($\kappa \geq 0.906$). The children were examined under artificial light while sitting in a dental chair. The examiners used a mouth mirror and blunt dental explorer. Triple syringes were used to dry the teeth before the examination.

Statistical Analysis

The data were analyzed using Statistical Package for the Social Sciences 19 software (SPSS, Chicago, IL, USA). Friedman, Kruskal-Wallis, and Mann-Whitney U nonparametric tests were used. The following dependent variables were dichotomized for the analysis: total score of impact on quality of life (0 = No impact, ≥ 1 = Impact) and the presence of MIH (0 = No, 1 = Yes). Gender (male and female), age (in years), DMFT and dmft indices (mean and standard deviation), and the presence of associated systemic factors (0 = No, 1 = Yes) were considered independent factors. To evaluate systemic factors that were associated with MIH, univariate conditional logistic regression was used to estimate odds ratios and respective 95% confidence intervals. For all of the analyses, a significance level of 5% was adopted.

Ethical Aspects

The investigation was conducted according to the Declaration of Helsinki and was approved by the Research Ethics Committee, Universidade Federal do Paraná (Protocol No. 13680513.2.0000.0102).

Results

A total of 93 children were examined, of which 62 (66.7%) were male. The age range of the sample was 6-13 years. The mean age was 8.5 years (SD = 1.48 years) in the case group and 8.3 years (SD = 1.49 years) in the control group ($p = 0.703$).

Among the children with MIH, a total of 339 incisors and first permanent molars were examined. Of these, 178 presented MIH, of which 116 (65%) had demarcated opacities, 39 (21.9%) had atypical restorations, and 23 (13.1%) had post-eruptive collapse. According to severity, 116 teeth (65.2%) were mild and 52 (34.8%) were severe.

No association was found between systemic factors in the prenatal period and MIH. In the perinatal period, premature infants had a 322% greater chance of presenting MIH, and prolonged deliveries were associated with MHI. Among the complications in the postnatal period, recurrent fevers were associated with a greater chance of MIH (Table 1).

The mean DMFT and dmft indices for both groups are presented in Figure 1. A significant difference between groups was found only in dental caries experience in permanent teeth, with a higher mean in the case group ($p = 0.001$).

Table 1. Univariate conditional logistic regression for the association of systemic factors in the case group (n = 31) and control group (n = 62).

Systemic Factors	Case N (%)	Control N (%)	Total N	OR	95% CI	p-value
Prenatal						
High Fever						
No	62 (67.4)	30 (32.6)	92	-	-	-
Yes	0 (0)	1 (100.0)	1			
Poor Nutrition						
No	27 (31.0)	60 (69.0)	87	1		
Yes	4 (66.7)	2 (33.3)	6	5.0	0.97-25.77	0.054
Use of Medication						
No	17 (32.7)	35 (67.3)	52	1		
Yes	13 (32.5)	27 (67.5)	40	1.15	0.47-2.77	0.763
Perinatal						
Prematurity						
No	24 (29.0)	58 (71.0)	82	1		
Yes	7 (64.0)	4 (36.0)	11	4.22	1.08-16.54	0.039*
Type of Delivery						
Normal	16 (31.4)	35 (68.6)	51	1		
Cesarean	15 (37.7)	27 (64.2)	42	1.23	0.50-2.99	0.651
Prolonged Delivery						
No	20 (27.0)	54 (73.0)	74	1		
Yes	11 (57.9)	8 (42.1)	19	3.23	1.18-8.87	0.023*
Intercurrences at Birth						
No	21 (28.8)	52 (71.2)	73	1		
Yes	10 (50.0)	10 (50.0)	20	2.5	0.96-6.54	0.060
Postnatal						
Asthma						
No	29 (33.3)	58 (66.7)	87	1		
Yes	2 (33.3)	4 (66.7)	6	1.00	0.18-5.46	1.000
Bronchitis						
No	22 (31.0)	49 (69.0)	71	1		
Yes	9 (40.9)	13 (59.1)	22	1.50	0.58-3.91	0.407
Pneumonia						
No	26 (32.5)	54 (67.5)	80	1		
Yes	5 (38.5)	8 (61.5)	13	1.44	0.34-6.11	0.619
Tonsillitis						
No	13 (33.3)	26 (66.7)	39	1		
Yes	18 (33.3)	36 (66.7)	54	1.00	0.43-2.34	1.000
Amoxicillin						
No	4 (28.6)	10 (71.4)	14	1		
Yes	20 (32.8)	41 (67.2)	61	1.00	0.99-1.00	0.585
Recurrent Fevers						
No	17 (25.0)	51 (75.0)	68	1		
Yes	14 (56.0)	11 (44.0)	25	3.57	1.23-9.52	0.011*

OR = Odds Ratio; CI = Confidence Interval; *Statistically significant.

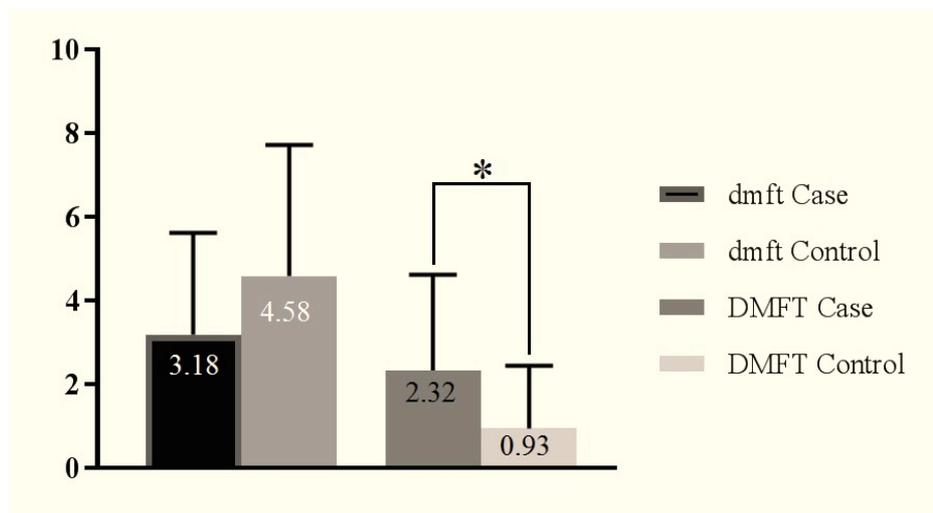


Figure 1. Association between MIH and caries experience in primary and permanent teeth in the case group (n = 31) and control group (n = 62). *Statistical significance at $p < 0.05$.

Of the 93 children, 57 were interviewed according to the CPQ₈₋₁₀. In six children who were older than 10 years of age, the CPQ₁₁₋₁₄ was used. The analysis of mean scores was performed only for the CPQ₈₋₁₀. For the CPQ₁₁₋₁₄, the mean score was 19 (SD = 2.83) in the case group and 13 (SD = 4.24) in the control group. No significant association was found between MIH and OHRQoL in 8- to 10-year-old children (Table 2). No significant difference was found between the overall mean CPQ₈₋₁₀ score in relation to MIH severity ($p = 0.571$).

Table 2. Mean overall scores and specific subscale scores on the CPQ₈₋₁₀ in the case group (n = 19) and control group (n = 38).

CPQ ₈₋₁₀	Case Group Mean (SD)	Control Group Mean (SD)	p-value
CPQ ₈₋₁₀ (Total Score)	17.84 (15.01)	23.53 (15.00)	0.100
Domains			
Oral Symptoms	5.42 (3.01)	7.53 (3.76)	0.068
Functional Limitations	3.84 (4.46)	4.58 (3.83)	0.322
Emotional Well-being	4.00 (4.64)	5.42 (4.73)	0.165

SD = Standard Deviation.

Discussion

Systematic factors during the pre-, peri-, and postnatal periods may be associated with MIH [2,14,15]. Maturation of the first permanent incisors and first molars occurs from the 28th week of intrauterine life and extends up to 36 months of life [27]. The present study found an association between the presence of MIH and prematurity and between MIH and prolonged delivery (i.e., >14h). Similar results were reported in previous studies that suggested more health interferences in premature infants or those who undergo prolonged births [28-30]. Moreover, respiratory problems, which are common in these groups, increase the risk of hypoxia, which may affect the normal function of ameloblastos [2,3,14,27,29,31]. Additionally, hypocalcemia in the premature newborn

can affect the development of dental enamel [31-33]. None of the interurrences during the prenatal period were related to MIH, which contrasts with previous findings [14,18].

Children with frequent episodes of fever during the first 3 years of life had a 3.57-times greater chance of having MIH than children without this interurrence, which is consistent with previous studies [31,32,34]. Fever symptoms are usually associated with most infections. Therefore, unclear is whether dental enamel alterations are specifically associated with episodes of fever or the underlying disease [32].

The present study found no association between the use of amoxicillin and MIH. The relationship between the occurrence of infection and the use of amoxicillin after birth with MIH onset is still controversial. A study of Turkish children found no association between antibiotic use and MIH [35], whereas other studies of Finnish, British, and Iranian children reported such a relationship [6,15,36]. However, some authors considered that enamel defects are likely related to underlying disease and not specifically to the use of amoxicillin [15,36].

A higher caries experience in permanent teeth was observed in the case group compared with the control group, corroborating the results of other studies [1,11,16,19,37-39]. Molar-incisor hypomineralization is a qualitative enamel defect, making teeth more susceptible to dental caries [4,11,16,17]. Teeth with MIH also present sensitivity and the retention of biofilms, thus favoring a greater risk of caries [11].

Previous studies have shown a relationship between defects of enamel development and OHRQoL [40-42]. A study of Brazilian children (11-14 years of age) found that enamel hypoplasia had a negative impact on the perception of oral health in children and their daily routine. The authors suggested that this type of defect is more severe and can cause tooth sensitivity or make the tooth more susceptible to caries, thus contributing to a lower quality of life [41].

To our knowledge, only one study has evaluated the relationship between MIH and OHLQoL. Children and adolescents, 11-14 years age, with more severe degrees of alterations presented worse OHRQoL compared with those without MIH [20]. Notably, the age range of the children in this previous study allowed the analysis of teeth that were affected by MIH over a longer period of time, resulting in a higher prevalence of post-eruptive enamel breakdown and consequently a greater impact on quality of life. The data from this previous study did not show an association between MIH and quality of life in 8- to 10-year-old children, and also when the different degrees of MIH severity were analyzed. More studies are needed to evaluate this relationship because the consequences of hypomineralization, such as post-eruptive collapse, are more common in older children [18,20,29].

Despite the relatively small sample of the present study, the methodological design followed well-defined criteria for case and control selection and sample calculation. However, considering the clinical impact of MIH (e.g., the development of carious lesions, the early loss of enamel, tooth sensitivity, and the need for recurrent and extensive restorative treatments) [4,5], longitudinal studies are required.

Conclusion

The present results suggest that prematurity, prolonged delivery, and recurrent fevers in the first 3 years of life significantly increase the chance of MIH. We also found a higher dental caries experience in permanent teeth among children with MIH.

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