Acta Odontologica Scandinavica, 2009; 67: 170–175

informa
healthcare

ORIGINAL ARTICLE

Prevalence and distribution of demarcated opacities and their sequelae in permanent 1st molars and incisors in 7 to 13-year-old Brazilian children

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Abstract

Objective. To determine the prevalence of demarcated opacities in permanent 1st molars and incisors in 7 to 13-year-old Brazilian children. ***Material and methods.*** The study population comprised 292 children from a middle social class public school in Rio de Janeiro, Brazil. Children with all 1st permanent molars erupted were eligible for participation. Clinical examination was performed by two calibrated examiners who recorded demarcated opacities, post-eruptive breakdown, atypical restorations, and extractions due to demarcated opacities. Forty-three children had at least one molar that could not be examined, which left 249 children for the data analysis. ***Results.*** One hundred children (40.2%) had one or more 1st molars with demarcated opacities with a mean number of 1.98 (SD 1.09) affected molars. The number of affected incisors increased with increasing number of affected molars. Twenty-two (18.6%) of 118 children with unaffected 1st molars had affected incisors. Demarcated opacities were the most frequent defect, and 1st molars and upper central incisors were the most frequently affected teeth. Among children with demarcated opacities in 1st molars, 20 (20%) had post-eruptive breakdown. ***Conclusions.*** A high prevalence of demarcated opacities, possibly resulting in disintegration of the tooth crown, has been found in Brazilian children.

Key Words: *Children, enamel defects, enamel opacities, epidemiology, MIH*

Introduction

Demarcated opacities are qualitative defects involving an alteration in the translucency of the enamel, which is otherwise normal in terms of thickness and smoothness of its surface. Demarcated opacities have a clear boundary with the adjacent normal enamel and can be white, creamy, yellow, or brown [1,2]. The term molar incisor hypomineralization (MIH) has been suggested for this condition, as it often affects permanent 1st molars and frequently also incisors [3]. One sequel of demarcated opacities is post-eruptive breakdown of the hypomineralized enamel, sometimes resulting in atypical fillings and, eventually, extraction [4].

Studies of the occurrence of demarcated opacities on permanent 1st molars and incisors have reported prevalence rates of 5.9% in children in Germany [5], 9.7% in children in Lithuania [6], 12.3% in children in Bosnia-Herzegovina [7], 13.7% in Italian children [8], 14.6% in English children [9], 18.4% in Swedish children [10], 19.3% in children in Finland [11], and 37.3% in Danish children [12]. As the number of affected teeth increases, so does severity of the defects [8,9,11]. The defects of the incisors are milder than those of the molars, and the lower incisors are less affected than the upper incisors [12–14].

The etiology of demarcated opacities in 1st molars and incisors is not fully understood. Possible causal factors mentioned in the literature are medical problems related to the child's birth [15], low birthweight [16], or health problems during the early years, such as asthma, otitis, tonsillitis, pneumonia, or bronchitis [15,17,18]. However, these associations were not supported by the findings of Leppaniemi et al. [11] and, moreover, other studies

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(Received 7 October 2008; accepted 19 January 2009)

ISSN 0001-6357 print/ISSN 1502-3850 online
DOI: 10.1080/00016350902758607

have found that complications related to pregnancy or birth are no more frequent in children with demarcated opacities than in children without such opacities [18,19]. Some studies have considered the association with environmental contaminants, such as exposure to dioxin or dioxin-like compounds and long-term exposure to polychlorinated biphenyls (PBCs) [20,21]. A recent study indicates a dose–response relationship between PBC exposure and developmental enamel defects of permanent teeth in children [22].

When demarcated opacities are complicated by post-eruptive loss of tooth substance, the affected teeth can become sensitive to cold and heat, which may cause the child to avoid these teeth when brushing and lead to increased stagnation of dental biofilm, increased risk of caries, and an increased need for restorative care [23,24]. Adequate restorative treatment may be difficult [17,25], and proper analgesia may be difficult to obtain, which will augment the risk of inducing dental fear and anxiety [3,13,14,25]. Hypomineralized teeth therefore constitute a severe clinical problem, and information on its occurrence is therefore important.

The aim of this study was to describe the prevalence and distribution of permanent 1st molars and incisors with demarcated opacities in a group of Brazilian children.

Material and methods

Study population and study design

The study was carried out at an elementary school supported by the State University of Rio de Janeiro, Brazil (Colégio de Aplicação da Universidade do Estado do Rio de Janeiro) – a public school with students from the middle social class. The great majority of mothers have finished high school and approximately one-third have graduated from university. The study was designed as a cross-sectional survey, and all 470 students between the first and seventh grades, between 7 and 13 years of age, were invited to participate. The study was approved by the Ethics Committee for Research of the University Hospital of the State University of Rio de Janeiro (1639/2006).

Of the original sample of 470 children, 292 (62.1%) signed informed consent and were examined. Among these, 43 were excluded due to absence of one or more permanent 1st molar and/or because they had a fixed orthodontic appliance. The final sample thus comprised 249 children, of whom 115 (46.2%) were girls and 134 (53.8%) were boys.

Clinical examination

After brushing their teeth themselves, the children had their teeth examined visually using dental mirrors. The teeth were not dried with air, but gauze was used to control moisture. The examinations were carried out by two calibrated examiners (C.T. and T.M.) under artificial light in the medical room of the school.

Each of the permanent 1st molars and incisors was given a score: "0" for absence or "1" for presence of a demarcated opacity, post-eruptive breakdown, an atypical restoration, or extraction due to demarcated opacities according to criteria previously described [4,26]. Diffuse opacities were not recorded [4].

After theoretical training, the examiners, together with a more experienced clinician (V.S.), examined 20 children who had previously been selected from the list of patients at the University Pediatric Dental Clinic as having demarcated opacities. Each examiner recorded the findings of each permanent 1st molar and incisor separately. If they were in doubt about the diagnosis, a decision was made after discussion. Of a total of 68 teeth, 45 (66.2%) presented one of the types of lesion recorded. Photographs were taken of all the teeth, which were examined and re-examined 4 weeks later, in order to assess intra- and inter-examiner reliability. Kappa coefficient for intra-examiner reliability was 0.90 for examiner 1, 0.96 for examiner 2, and 0.80 for inter-examiner reliability.

Statistical analysis

Data were analyzed using SPSS v. 8.0 (SPSS Inc., Chicago, Ill., USA). A descriptive analysis of the prevalence and distribution of the clinical recordings was made and McNemar's test was used to test the association between presence of demarcated opacities in permanent 1st molars and incisors. Odds ratio was calculated to test difference in the prevalence of demarcated opacities between boys and girls.

Results

Data analysis was based on two different groups; one of individuals with all permanent 1st molars erupted ($n = 249$), the other of individuals with all permanent 1st molars and incisors erupted ($n = 194$). Table I gives the distribution of children according to number of affected teeth.

A total of 100 (40.2%) among 249 children had one or more affected permanent 1st molar. In the group also having all incisors erupted, 76 (39.2%) children had at least one affected molar. The prevalence in the group of 249 individuals did not differ significantly between girls (37.4%) and boys (42.5%) (OR: 0.81; 95% CI: 0.49–1.34). The same was true for those whose permanent 1st molars and incisors had all erupted (girls 36.6% and boys 41.6%) (OR: 0.81; 95% CI 0.45–1.44).

Table I. Distribution of children according to the number of affected permanent 1st molars. Among the 194 children with all permanent 1st molars and incisors erupted, the mean number of affected incisors (SD) is given according to the number of affected permanent 1st molars.

	No. of affected permanent 1st molars (*n* (%))				
	0	1	2	3	4
Children with all permanent 1st molars erupted ($n=249$)	149 (59.8%)	45 (18.1%)	27 (10.8%)	13 (5.2%)	15 (6.0%)
Children with all permanent 1st molars and incisors erupted ($n=194$)	118 (60.8%)	34 (17.5%)	20 (10.3%)	12 (6.2%)	10 (5.2%)
Mean number of affected incisors (SD)	0.31(0.91)	0.59 (0.85)	0.75 (1.25)	1.42 (1.08)	1.80 (1.93)

The overall mean number of affected molars was 0.80 (SD 1.19) in the group of 249 individuals. Considering only those with demarcated opacities, 198 molars were affected in the 100 affected individuals, which produced a mean number of 1.98 affected molars (SD 1.09) per affected child. In the children who also presented all incisors ($n=194$), the mean number of affected molars was 0.77 (SD 1.17). Among those with demarcated opacities, 150 affected molars were observed in 76 children, which yielded a mean number of 1.97 (SD 1.07). Table I also indicates that the mean number of affected incisors rose by the increasing number of affected 1st molars.

About half of the individuals with affected molars also had affected incisors (47.4%), while this was true of only 1 in 5 (18.6%) who had no affected molar (Table II). The difference was statistically significant ($\chi^2=4.60$; d.f. $=1$; $p=0.03$).

Demarcated opacities were the most frequent type of lesion, and permanent 1st molars and upper central incisors the most frequently affected teeth (Table III). While 14.1% of the upper central permanent incisors presented demarcated opacities, the same finding was observed in only 4.4% to 8.3% of the other incisors.

Post-eruptive breakdown was the second most common finding, i.e. observed in approximately 2% of permanent 1st molars. Only one incisor, a lower lateral, had post-eruptive breakdown. The frequency of atypical restorations ranged from 1.2% to 1.6% among permanent 1st molars. Only one incisor, a lower central incisor, had an atypical restoration. Only two molars, one lower left 1st molar and one lower right 1st molar, were considered to have been extracted due to hypomineralization.

Table II. Distribution of 194 children with all permanent 1st molars and incisors erupted according to presence of demarcated opacities in permanent 1st molars and incisors.

	Demarcated opacities in one or more incisor		
Demarcated opacities in one or more 1st molar	Present	Absent	Total
Present	36 (47.4%)	40 (52.6%)	76 (100.0%)
Absent	22 (18.6%)	96 (81.4%)	118 (100%)
Total	58	136	194

Enamel surface loss was twice as frequent in children with three or four affected molars as in children with one or two affected permanent 1st molars (difference 16.9%; 95% CI: 0.5–36.5%), indicating that severity of the lesions is aggravated by the number of affected permanent molars.

Discussion

The prevalence of demarcated opacities on permanent 1st molars and incisors in this population was high (>40%). The most frequently affected teeth were permanent 1st molars, closely followed by upper central incisors, and only a few teeth showed lesions with post-eruptive breakdown of the tooth surface.

Although not all the eligible subjects participated, we believe that the risk of bias due to non-attendance is low, as the sample was representative of the school in terms of social class, and because the parents of the non-attending children did not actively refuse to consent to let their child participate but simply did not respond to the invitation. This indicates that they simply forgot to return the consent form. Furthermore, it is unlikely that parents' acceptance of their children's participation in the study was influenced by their child's dental conditions, since most parents are unaware of their children's potential dental problems related to demarcated opacities.

The diagnostic criteria applied in this study required that the enamel defect be clearly visible and that there be a clear demarcation between the sound and the affected enamel. It is well known that extensive drying of tooth enamel can result in an overestimation of the prevalence of opacities. It should, therefore, be mentioned that even though gauze was used to control moisture, the teeth were not dried before examination. The size of the lesions, however, was not taken into consideration; lesions were recorded even if their diameter was less than 2 mm, which is a cut-off point used in other studies [8,10,11]. The possibility of confusing demarcated opacities with diffuse opacities always to some extent

Table III. Distribution of permanent 1st molars and incisors according to type of lesion in 249 children.

Condition	Tooth															
	16		12		11		21		22		26		36		32	
	n	(%)	*n*	(%)	*n*	(%)	*n*	(%)	*n*	(%)	*n*	(%)	*n*	(%)	*n*	(%)
Sound	207	(83.1)	187	(91.7)	204	(86.1)	204	(85.7)	192	(95.5)	205	(82.3)	199	(79.9)	213	(91.8)
Demarcated opacity	35	(14.1)	17	(8.3)	33	(13.9)	34	(14.3)	9	(4.5)	38	(15.3)	42	(16.9)	18	(7.8)
Post-eruptive breakdown	4	(1.6)	0	(0)	0	(0)	0	(0)	0	(0)	2	(0.8)	4	(1.6)	1	(0.4)
Atypical restoration	3	(1.2)	0	(0)	0	(0)	0	(0)	0	(0)	4	(1.6)	3	(1.2)	0	(0)
Extraction	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	1	(0.4)	0	(0)

Condition	Tooth							
	31		41		42		46	
	n	(%)	*n*	(%)	*n*	(%)	*n*	(%)
Sound	234	(94.0)	237	(95.2)	222	(95.3)	187	(75.1)
Demarcated opacity	15	(6.0)	11	(4.4)	11	(4.7)	51	(20.5)
Post-eruptive breakdown	0	(0)	0	(0)	0	(0)	6	(2.4)
Atypical restoration	0	(0)	1	(0.4)	0	(0)	4	(1.6)
Extraction	0	(0)	0	(0)	0	(0)	1	(0.4)

exists in clinical data. However, the difference between diagnostic criteria for these two conditions was emphasized during training of the examiners in order to eliminate this type of misclassification. The prevalence estimates were comparable to those observed by Wogelius et al. [12] in Danish children, but considerably higher than those found in studies [8,10,11] in which only lesions with a diameter of more than 2 mm were included. On the other hand, our estimates were higher than those obtained by Jasulaityte et al. [6], who also recorded opacities with a dimension below 2 mm. In the study by Wogelius et al. [12], children were examined during their routine appointments. These authors mention that children with demarcated opacities might receive more attention at recall in the dental care system, which could have caused the prevalence to be overestimated. However, this could not be the case in the present study because the children were examined at school.

Demarcated opacities are usually considered mild lesions, while opacities with additional post-eruptive breakdown are considered moderate or severe, depending on the extent of tooth surface loss [5,8,10]. Jasulaityte et al. [6] proposed two severity levels: demarcated opacities, i.e. mild forms of demarcated opacities without disintegration of the enamel, and severe cases, i.e. defects with disintegration. Disintegration defects include post-eruptive breakdown, atypical restorations, and extraction due to hypomineralization.

In the present study, most of the affected children had only demarcated opacities. Although the proportion of children with severe lesions in our study is in accordance with the findings of some researchers [5,7], it differs from others [6,10,11] who found a higher proportion of children with severe enamel defects.

Molars and incisors were not equally affected, as also reported in other studies [13,14]. Post-eruptive breakdown and atypical restorations were observed mainly in molars and only two 1st molars had been extracted due to demarcated opacities. The severity of the lesions affecting molars increased with the number of affected molars, as also observed in previous studies [6,11]. Incisors presented almost only demarcated opacities and the upper central incisors were more affected than the upper lateral incisors and all the lower ones. It was observed that almost half of the affected children (47.4%) had both molars and incisors affected. In addition, as more molars were affected, an increase in the mean number of affected incisors was noted, indicating that the etiology of demarcated opacities may be partly systemic. However, in children who had no molars affected, 18.6% had demarcated opacities in one or more incisors. We believe that, in these cases, the presence of opacities in the incisors was probably related to unrecognized trauma in the primary

Table IV. Distribution of 100 children with demarcated opacities according to severity of the lesions and number of affected permanent 1st molars.

	Demarcated opacities without tooth surface loss	Post-eruptive breakdown, atypical restoration or extraction	Total
Children with 1 or 2 1st molars affected	61 (84.7%)	11 (15.3%)	72 (100%)
Children with 3 or 4 1st molars affected	19 (67.9%)	9 (32.1%)	28 (100%)
Total	80 (80.0)	20 (20.0)	100

incisors or other local, unspecified types of insult during tooth development. Furthermore, it cannot be completely excluded that affection solely of incisors can occur, just as molars can be solely affected. For this reason, we have not used the terminology MIH in our study, since we are not able to fully ensure that all demarcated opacities recorded are in agreement with the definition of MIH. Although a number of possible causes of demarcated opacities in 1st molars and incisors have been reported in the literature, the etiology has not yet been fully clarified, and the results of existing studies are controversial [11,13–19].

Given the present poor understanding of the etiology of MIH, the high prevalence of demarcated opacities in children, eventually resulting in disintegration of the tooth crown, remains an important issue in pediatric dentistry.

Declaration of interest: The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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