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ORIGINAL ARTICLE

Breakdown in Hypomineralization in Deciduous Teeth: An Association between Anthropometric, Orthodontic and Dental Caries Data

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ABSTRACT

Objective: To analyze the association of dental tissue fracture related to hypomineralization and its association with anthropometric, orthodontic, and dental caries in deciduous teeth. **Material and Methods:** A cross-sectional study was conducted with 313 children aged 6 to 10. Data were collected through clinical examination based on criteria from the European Academy of Pediatric Dentistry (EAPD) for the diagnosis of hypomineralization. Facial biotype analysis was conducted based on collected data. Orthodontic data were collected in terms of Angle classification and malocclusions. The diagnosis of dental caries was guided by ICDAS II (International Caries Detection and Assessment System) parameters. Statistical analysis involved descriptive analysis, Fisher's exact test, and the chi-squared test. **Results:** 23.3% of children had hypomineralization in deciduous, and 20.4% had post-eruptive breakdown preceded by hypomineralization (PEBH). The analyses indicated that weight, height, facial biotype, and malocclusions are not significantly associated with PEBH. Dental caries was associated with the presence of hypomineralization ($p<0.001$) and breakdown in deciduous teeth ($p<0.001$). **Conclusion:** An association between dental caries, hypomineralization, and PEBH was found for deciduous teeth. Orthodontic and anthropometric parameters were not associated with post-eruptive breakdown preceded by hypomineralization.

Keywords: Dental Enamel Hypomineralization; Dental Caries; Prevalence; Dental Enamel.

Introduction

Dental enamel is a structure formed during gestation and early childhood in a process called amelogenesis. This tissue may exhibit defects during the initial calcification or throughout the child's growth and development due to several physiopathological disorders, such as cardiovascular and pulmonary issues or even fever [1,2]. Formation of hypomineralized enamel with high carbon (C) content, as well as low phosphorus (P) and calcium (Ca) content, are defects that lead to significantly lower mechanical properties, such as lower hardness values, than unaffected teeth [3]. Therefore, it is a risk factor for caries, post-eruptive dental tissue breaks, pain, and dental hypersensitivity [2,4].

Hypomineralization is a problem with a complex etiology recognized as a potential public health [5]. The manifestation of MIH varies according to its severity, encompassing a spectrum from white-creamy or yellow-brown opacities to enamel breakdown occurring after the eruption, along with atypical caries found on one or more first permanent molars, potentially involving incisors as well. Moreover, the color of the hypomineralized lesion and masticatory forces may be related to a higher risk of post-eruptive breakdown preceded by hypomineralization (PEBH) [6]. However, there still needs to be more evidence in the literature regarding other variables that may contribute to such outcomes, mainly related to increased force on the affected site. In this regard, it is important to analyze craniofacial morphology, weight, and height since these anthropometric features influence the intensity of masticatory force [7]. Several dental and skeletal malocclusion types are considered risk factors for dental occlusion unbalance [8]. Therefore, increasing masticatory forces due to these factors may lead to a greater predisposition to enamel/ dentin breakdown in teeth with hypomineralization.

This is the first study to evaluate the association between orthodontic and anthropometric parameters (weight, height, and facial biotype) and enamel or dentin fractures due to the previous existence of hypomineralization in both dentitions. Furthermore, this study will analyze caries' prevalence and association with hypomineralization and PEBH. Two null hypotheses were tested. First, there is no difference between anthropometric and orthodontic parameters and post-eruptive enamel or dentin decay. The other null hypothesis was that dental caries have no association with such breaks or hypomineralization.

Material and Methods

Study Design and Ethical Clearance

This is an observational and cross-sectional study in which children aged 6 to 10 from public schools in Maceió, State of Alagoas, Brazil, were investigated. This present study was approved by the Federal University of Alagoas Ethics Committee, under Opinion No. 3.838.819. This study followed the ethical precepts of the Helsinki Declaration of the World Medical Association. Consent for participation in this research was obtained by signing the Informed Consent Form (ICF) sent to parents or guardians and the Informed Consent Form (ICF) by the child.

Sample Size

Sample size calculation was performed using the Epi Info™ (Centers for Disease Control and Prevention) software, considering the following parameters: the prevalence of enamel defect in the world child population equal to 13.5% - according to a previous study [9], a confidence interval of 99% and standard error of 5%. Based on this calculation, the minimum sample required for this investigation was 310 children.

Exclusion Criteria

Children with fixed orthodontic appliance, dental fluorosis, amelogenesis or dentinogenesis imperfecta, or syndromes were excluded from this research due to potential diagnostic bias.

Data Collection

Data collection started in April 2022 and ended in December 2022. The data collection was performed by two researchers who had previously trained to diagnose all variables involved in this study using a structured questionnaire. The children were measured and weighed to assess the adequacy of weight and height for age and gender, considering parameters of the Centers for Disease Control and Prevention (CDC) [10,11] and of the World Health Organization [12]. After individual calculation and obtaining the z-score, the children were classified as (1) short, normal, or tall stature and (2) weight below average, normal, or high in terms of the recommended average in terms of age and gender. The child's facial pattern was classified as brachyfacial, mesofacial, or dolichofacial [13] through the visual analysis of the horizontal and vertical dimensions of the face through the observational approach performed by previously trained researchers.

The orthodontic parameters consisted of a sequence of dependent variables listed below:

- Angle Class: Participants were classified according to molar relationship into Class I, II, and III. Whenever it was not possible to classify due to the absence of permanent molars, the relationship between the canines (canine key) was used for this purpose.
- Overjet and overbite: Values between 0 and 3 mm were considered normal.
- Anterior and posterior crossbite: Crossing of at least one tooth in the anterior or posterior region of the dental arch segments. Posterior crossbite was classified as unilateral (right or left) or bilateral.
- Open bite: Absence of vertical contact between the teeth of the upper and lower arches, either posterior or anterior.
- Presence of midline shift: The dental arches were not aligned along the mid-sagittal line.

Hypomineralization was diagnosed according to the European Academy of Pediatric Dentistry (EAPD) criteria for both dentitions [14]. Such parameters were based on the presence of demarcated opacities, post-eruptive enamel breakdown (restricted to enamel or exposed dentin), or atypical restoration (restorations with shape and size that do not coincide with the caries image) in deciduous teeth. A tooth was considered extracted due to a previous enamel defect when evident signs of hypomineralization were observed in homologous teeth in the mouth [14].

For each tooth surface, the following scores were assigned: normal (N), marked opacity (OD), post-eruptive enamel breakdown (PEB), post-eruptive dentin breakdown (PDB), atypical restoration (AR) or extracted (EXT). The demarcated opacities were classified according to their color into creamy-white (CW) or yellowish-brown (YB). For further analyses, the tooth surfaces were grouped as exposed to masticatory forces (occlusal, lingual of upper molars, and buccal of lower molars) or not exposed to masticatory forces (buccal of upper molars, lingual of lower molars, and proximal surfaces).

In case a tooth surface presented more than one feature of hypomineralization, the following priority sequence was followed: extracted due to hypomineralization > atypical restoration > post-eruptive breakdown with dentin exposure > post-eruptive enamel breakdown > yellowish-brown opacity > creamy-white opacity. In case of doubt about the severity of hypomineralization, the examiner was instructed to consider the surface as being at an anterior level [14].

To verify post-eruptive breakdown due to the previous existence of hypomineralization, the following variables were combined for both dentitions: post-eruptive enamel breakdown (PEB), post-eruptive dentin breakdown (PDB), atypical restoration (AR) and extracted (EXT).

The ICDAS II (International Caries Detection and Assessment System) parameters were used for dental caries. The caries lesions were classified as follows: 0. healthy; 1. first visible change in enamel; 2. distinct visual change in enamel; 3. localized cavitation only in the enamel; 4. shadowing of underlying dentin; 5. cavitation in enamel with dentin exposure; 6. extensive cavitation with dentin exposure; or in: A. Absent; X. Extracted; F. Fracture [15]. Using the ICDAS II classification, we calculated the dmft (decay – missing – filled in deciduous teeth) indices [16].

All children were invited to have their teeth brushed at school before the examination. The clinical examination was performed in the schoolyard under good natural lighting and using torches, gloves, wooden spatulas, dental mirrors, and sterile gauze whenever necessary. The children were positioned in suitable seats provided by the school, and the researcher took a position in a chair in front of them, performing a thorough analysis of each dental surface. Kappa coefficients for an intra-examiner agreement were K = 0.90 and K = 0.88, respectively.

Data Analysis

After data collection and the categorization of variables, a database was created for statistical analysis in SPSS (Statistical Package for the Social Sciences) version 23 (IBM Corp., Armonk, NY, USA). The normal distribution of data was verified with the Kolmogorov-Smirnov test. The chi-squared or Fisher's exact test assessed the association between two categorical variables when conditions warranted. The margin of error was 5%, with a confidence interval of 95%. P-values lower than 0.05 were considered statistically significant.

Results

Three hundred and thirteen children of both genders were analyzed. The mean age of the children was 8.12±1.26 years old, of which 42.2% were male and 57.8% were female. Twenty-three percent of children had at least one hypomineralized lesion in the deciduous teeth, 62% in deciduous posterior teeth, and 12% in deciduous anterior teeth. However, no statistically significant difference was found between gender and hypomineralization ($p>0.05$).

Deciduous teeth concentrated most of these breaks (20.4%). Regarding hypomineralization, no statistically significant difference was found between gender and post-eruptive tissue breakdown ($p>0.05$). In total, 3130 deciduous teeth were analyzed. Sixteen deciduous teeth showed marked opacity; 12.5% were creamy-white, and 87.5% were yellowish-brown. The centric contention cusp was more affected by hypomineralization (69.5%) than the balancing cusp (30.5%) in molars.

78.9% of children had at least one caries lesion. The dmft indices of the children were 2.89±2.92. When affected by caries, the anterior deciduous incisors had ICDAS scores 1 and 2. Canines had ICDAS scores 2-4, and deciduous molars concentrated the deepest lesions, between ICDAS scores 4-6.

Regarding anthropometric data, the most frequent facial types were mesofacial individuals (49.2%), followed by dolichofacial (27.5%) and brachyfacial individuals (23.3%). The mean weight of the children was 31 ± 9.41 kg and a height of 131.73 ± 12.41 cm. 76% of the children were of normal height, 2.2% were short, and 21.7% were tall for their age. Regarding the weight presented, 7% were below the average, 49.5% were within the average, and 43.5% were above the average for their age. Table 1 shows that no statistically significant difference was found between anthropometric parameters (facial type, weight, and height) and post-eruptive breakdown (p>0.05).

Regarding Angle's classification, it was possible to verify that 59.1% of individuals were in Class I, 28.1% in Class II, and 8.3% in Class III. For 4.5% of the children, it was not possible to establish Angle's occlusion key, either by the absence of permanent molars or canines. Regarding malocclusions, 14.1% anterior crossbite, 8.6% posterior crossbite, 10.2% overjet, 22.4% overbite, 15.3% open bite, and 9.3% midline deviation were possible to verify in the children.

Table 1 shows that no statistically significant difference was also found between the prevalence of post-eruptive breakdowns due to hypomineralization and Angle's classification (p>0.05) or even for any of the malocclusions analyzed (p>0.05) (Table 1).

Table 1. Post-eruptive breakdowns in deciduous teeth due to previous hypomineralization and their relationship with anthropometric and orthodontic variables.

Variables	Breakdowns (Deciduous Teeth)		Total	p-value
	No N (%)	Yes N (%)	N (%)	
Facial Type				
Brachyfacial	61 (83.5)	12 (16.5)	73 (100.0)	0.563(1)
Mesofacial	122 (79.2)	32 (20.8)	154 (100.0)	
Dolicofacial	66 (76.8)	20 (23.2)	86 (100.0)	
Stature				
Low	7 (100.0)	0 (0.0)	7 (100.0)	0.446(2)
Normal	190 (78.3)	48 (21.7)	238 (100.0)	
High	52 (76.5)	16 (23.5)	68 (100.0)	
Weight				
Below average	18 (81.8)	4 (18.2)	22 (100.0)	0.951(2)
Average	122 (78.7)	33 (21.3)	155 (100.0)	
Above average	109 (80.1)	27 (19.9)	136 (100.0)	
Angle Class				
Class I	145 (78.4)	40 (21.6)	185 (100.0)	0.603(1)
Class II	72 (81.8)	16 (18.2)	88 (100.0)	
Class III	19 (73.0)	7 (27.0)	26 (100.0)	
Anterior Crossbite				
Absent	218 (81.0)	51 (19.0)	269 (100.0)	0.107(1)
Present	31 (70.5)	13 (29.5)	44 (100.0)	
Posterior Crossbite				
Absent	229 (80.0)	57 (20.0)	286 (100.0)	0.460(1)
Present	20 (74.0)	7 (26.0)	27 (100.0)	
Overjet				
Absent	220 (78.3)	61 (21.7)	281 (100.0)	0.101(1)
Present	29 (90.6)	3 (9.4)	32 (100.0)	
Overbite				
Absent	195 (80.2)	48 (19.8)	243 (100.0)	0.570(1)
Present	54 (77.1)	16 (22.9)	70 (100.0)	
Open Bite				
Absent	209 (78.8)	56 (21.8)	265 (100.0)	0.480(1)
Present	40 (83.3)	8 (16.7)	48 (100.0)	
Midline Shift				
Absent	226 (79.6)	58 (20.4)	284 (100.0)	0.973(1)
Present	23 (79.3)	6 (20.7)	29 (100.0)	

(1)Chi-squared test; (2)Fisher's Exact Test.

A statistically significant association was found between the occurrence of caries and the prevalence of hypomineralization in deciduous teeth (p<0.05). A statistically significant association was also observed for deciduous teeth (p<0.05) regarding the association between post-eruptive breakdowns and dental caries.

Table 2. Association between dental caries, hypomineralization, and post-eruptive breakdowns.

Variables	Dental Caries		Total	p-value	RR (95% CI)
	No N (%)	Yes N (%)	N (%)		
Hypomineralization in deciduous teeth					
No	61 (24.5)	179 (75.5)	249 (100.0)	0.001(1)*	1
Yes	5 (7.3)	64 (92.7)	64 (100.0)		1.24 (1.13 to 1.37)
Breakdowns in deciduous teeth					
No	63 (25.6)	186 (74.4)	246 (100.0)	0.001(1)*	1
Yes	3 (4.7)	61 (95.3)	64 (100.0)		1.27 (1.16 to 1.39)

(1)Chi-squared test; *Significant association at 0.05%.

Discussion

The first null hypothesis was supported by the results obtained in this study, as no statistically significant association could be found between anthropometric or orthodontic parameters and post-eruptive enamel or dentin breakdown (Table 1). Thus, this study suggests that anthropometric data such as facial biotype, weight, height, and parameters for malocclusion diagnosis and Angle's classification are not considered risk factors for the occurrence of post-eruptive breakdowns in deciduous teeth previously affected by hypomineralization.

Regarding the second null hypothesis, the results obtained show that it cannot be rejected, as a significant association was observed between the prevalence of caries and the presence of hypomineralization, as well as the presence of post-eruptive breakdown preceded by hypomineralization in deciduous teeth.

Similar to previous studies [9,17-19], the results of the present study indicate that gender does not play a statistically significant role in the occurrence of hypomineralization. However, these findings differ from studies conducted in India, such as the study carried out by Rai et al. [20], which reported a significantly higher prevalence of hypomineralization among boys (24.8%) compared to girls (20.0%). Likewise, the study by Padavala and Sukumaran [21] reported a more excellent distribution of this dental feature among males.

Previous studies suggest that the predominant coloring in cases of hypomineralization in deciduous second molars is creamy-white [22,23]. On the other hand, in the present study, the most prevalent color in the deciduous dentition was yellowish-brown. The mean age of the children studied was 8.12±1.26 years old. In contrast, in the studies of Goyal et al. [22] and Mittal and Sharma [23], this mean was 4.25±0.5 and 6.45±1.46 years old, respectively, which indicates that the deciduous teeth in this study were subjected to harmful environmental conditions of the oral cavity for a more extended period. Since teeth affected by hypomineralization have a more porous tissue framework [24], the time spent in the oral cavity may suggest such a change in coloring. On the other hand, lesion color is related to the severity of hypomineralization, with yellowish-brown defects that are more porous and prone to post-eruptive fractures [14].

Still, regarding deciduous teeth, it is important to emphasize that the results suggest that these teeth are significantly more susceptible to post-eruptive breaks, which can be explained by the fact that they present lower mineralization and microhardness than permanent teeth [25]. Moreover, deciduous and mixed dentition occlusion are more susceptible to changes [26]. Thus, with consequent imbalances conditioned to motor development and maturation of the central nervous system [27]. Such imbalance may increase masticatory tension and occlusal wear on specific points of the dentition, causing stress points on teeth susceptible to post-eruptive breakdowns, such as hypomineralized teeth. With the first and second occlusion lifts, such a period becomes evident through mandibular destabilization.

The data from the present study indicate that the working cusp of posterior teeth was the region most affected by fractures in both dentitions, suggesting that the location of this cusp may be considered a predilection site for post-eruptive breakdowns. The working cusps, Located in the labial surfaces of mandibular teeth and palatal surfaces of maxillary teeth, are the most susceptible areas to tension, breaks, and wear since they are responsible for centric containment in occlusion and grinding food [28].

According to the study by Araujo et al. [29], bite force is associated with body skeletal muscle mass, body mass index, and the need for orthodontic treatment. Based on this information, this study aimed to investigate whether these variables influence bite force and whether they could be associated with post-eruptive breakdown in teeth affected by hypomineralization. However, the results presented herein do not corroborate such a theory, although the conduction of longitudinal studies is recommended to establish a better cause-effect relationship.

Few studies have evaluated the relationship between morphological and functional features of the masticatory apparatus in children and adolescents. The Marquezin et al. [30] survey observed that orofacial dysfunction, i.e., the need for orthodontic treatment and masticatory performance, had a statistically significant association. Moreover, the increase in masticatory force was also significantly associated with an increase in the need for orthodontic treatment. However, the data obtained by the present study show a non-significant association between malocclusions and post-eruptive breakdowns preceded by hypomineralization.

A systematic review showed that Class II and Class III individuals present asymmetrical in the activities of the stomatognathic apparatus, with a consequent imbalance in the distribution of occlusal forces [31]. However, this study did not observe a higher prevalence of eruptive breakdown cases in these groups. Still, from the relationship between morphology and masticatory force, it has been found that individuals with brachyfacial facial profiles have greater masticatory force than mesofacial and collofacial individuals [32]. However, this did not translate into a higher prevalence risk for post-eruptive breakdowns in this study.

The present study showed a statistically significant association between caries, hypomineralization, and post-eruptive breakdowns in deciduous teeth. When enamel mineralization is deficient, it becomes more porous and fragile, which facilitates bacteria adhesion and plaque formation [33]. Thus, hypomineralization may increase the risk of developing dental caries since the acids produced by bacteria can more easily penetrate weakened enamel. Moreover, hypomineralization may hinder caries treatment, making the tooth more susceptible to new lesions [34]. Hypomineralization is a condition in which there is a deficiency in the mineralization of tooth enamel and may lead to increased susceptibility to dental caries.

This study presents some limitations inherent to its cross-sectional design, which makes it unable to establish cause-and-effect relationships among the variables studied. In this regard, it is essential to emphasize that the study is representative of its population and is a pioneer regarding the association between anthropometric data, dental caries, hypomineralization, and post-eruptive dental tissue breakdowns. It is also crucial to consider whether the evaluation of children's oral health is influenced by several factors, including their socioeconomic and psychological conditions.

Conclusion

A statistically significant association was found between hypomineralization and caries in deciduous teeth and caries and post-eruptive breakdowns in deciduous teeth. However, anthropometric and orthodontic parameters were not associated with post-eruptive breaks in teeth with hypomineralization. Thus, specific prevention strategies should be implemented when the previous existence of hypomineralization is observed.

Authors' Contributions

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PTMN	https://orcid.org/0009-0000-0851-141X	Conceptualization, Methodology, Investigation, Data Curation, and Writing - Original Draft.
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All authors declare that they contributed to a critical review of intellectual content and approval of the final version to be published.		

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None.

Conflict of Interest

The authors declare no conflicts of interest.

Data Availability

The data used to support the findings of this study can be made available upon request to the corresponding author.

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