Chronological Age and Nolla's stages in first permanent molars in children: radiographic observation

DDS. Melanie Fernanda Ferrín Yépez[1]; PhD Scholar. Angélica Miranda Arce[2*]; PhD Ángela Mercedes Murillo Almache[3]

[1.]San Gregorio de Portoviejo University, Dentist graduated, Portoviejo, Ecuador Dentist graduated from San Gregorio University of Portoviejo; Conceptualization, Validation, Formal Analysis, Investigation, Data Curation, Writing – Original Draft Preparation, Writing – Review & Editing *ORCID:https://orcid.org/0009-0003-9854-6393* EMAIL: melanieferrin59@gmail.com e.mfferrin@sangregorio.edu.ec

[2*] Associate Teacher and researcher at the School of Dentistry, San Gregorio University of Portoviejo; 2.-San Gregorio de Portoviejo University, Associate Teacher and researcher at the School of Dentistry, Portoviejo, Ecuador Conceptualization, Methodology, Software, Formal Analysis, Investigation, Resources, Writing – Original Draft Preparation, Writing ORCID:https://orcid.org/0009-0003-9854-6393 EMAIL: angelicamirandaarce86@gmail.com

[3]Associate Teacher, Head of the Public Health Area, Researcher at the School of Dentistry, San Gregorio University of Portoviejo3.- San Gregorio de Portoviejo University, Associate Teacher, Head of the Public Health Area, Researcher at the School of Dentistry, Portoviejo, Ecuador Methodology, Validation, Formal Analysis , Writing – Original Draft Preparation, Review & Editing, Supervision, Project Administration *ORCID : https://orcid.org/0000-0003-2158-1871* EMAIL: angmur12000@yahoo.com ammurillo@sangregorio.edu.ec

Abstract:

Introduction: Nolla's method evaluates dental age in permanent teeth, classifying it on a scale from 0 to 10; The objective of this study is to determine the chronological age and Nolla stages in the first permanent molars through radiographic observation of pediatric dental patients treated at the Dental Clinics of San de Portoviejo University, from January to December 2023.

Materials and methods: This study is observational, cross-sectional, and retrospective. A non-probabilistic sample was selected for convenience, including 301 panoramic radiographs from ages 4 to 9 years. The maturation stages were assigned to the first permanent molars according to Nolla's method of recording dental age. The relationship between chronological age and the Nolla stage of dental mineralization was calculated using a Pearson Chi-square test.

Results: There was a significant relationship ($p<0,05$) between chronological age and dental age, according to Nolla.

Conclusions: From the study results, it can be concluded that the Nolla method classification can be used for the estimated chronological age of the target population. Furthermore, at the age of 8 years, a higher frequency of stage 9 was evident. However, the significant relationship between chronological age and dental mineralization highlights the validity of this method in clinical practice.

Keywords: Tooth germ; Pediatric Dentistry; Radiography; Age Determination by Teeth; Odontogenesis.

Introduction

Dental development in childhood is a fundamental process that influences oral health throughout life, making it essential in pediatric dentistry for optimal diagnosis and treatment (1). In 1960, Dr. Carmen Nolla developed the Nolla stages method, which determines dental age, aiming to comprehensively analyze permanent dentition through X-rays. The morphology of the root is also evaluated to detect dilacerations and other possible alterations. This method classifies tooth maturation on a scale from 0 to 10, considering the phases of mineralization of permanent teeth, from the crypt to the closure of the root apex. Consequently, the first permanent molars, which erupt at around six to seven years of age, are key indicators in the evaluation of dental growth in children (2),(3),(4).

Stage 0 indicates the absence of formation of the tooth germ, stage 1 presence of the tooth germ, stage 2 beginning of crown calcification, stage 3 one-third of the crown, stage 4 two-thirds of the crown, and stage 5 almost all the crown, stage 6 entire dental crown, stage 7 one-third of the root, stage 8 two-thirds of the root, stage 9 almost the entire root, stage 10 complete fusion of the dental roots (5). According to the determined calcification phases, each of the teeth obtains a score according to the degree of maturity that is present. Therefore, the sum of the points has become a fundamental technique for estimating dental age (6). Likewise, this classification studied by Nolla is used in teaching and clinical practice in various populations, allowing the estimation of chronological age, established by the day a person is born and the time elapsed since that date (2),(7),(8).

However, it is essential to consider the factors that affect the chronology of dental eruption since problems may arise in patients when a delay in the emergence of teeth occurs. This situation can result in incorrect occlusion, meaning that a child's teeth do not erupt at the expected time or within the time range established as normal for their age (9),(10).

Therefore, discrepancy is generated when trying to establish a precise chronology of permanent tooth eruption, because it is influenced by various factors, such as; sex, diet, age, geographical location, race, and present health problems (11).
The objective of this research was to determine the chronological age and Nolla stages in the first permanent molars through radiographic observation of pediatric dental patients treated at the Dental Clinics of San Gregorio de Portoviejo University during the period from January to December 2023. It has been hypothesized that there is a direct relationship between chronological age and the stage of dental mineralization of Nolla in the investigated population.

Material and methods

Study design

The present study is observational, non-experimental, descriptive, cross-sectional, and retrospective. The inclusion criteria included radiographs of patients between the ages of 4 and 9 years who had panoramic radiographs with good contrast and clarity. On the other hand, the exclusion criteria were considered, ruling out low-quality radiographs that did not allow correct identification of tooth germs and incomplete sociodemographic data. Sampling was applied in a non-probabilistic way for convenience.

Data collection.

The target population of this study consisted of panoramic radiographs of patients between 4 and 9 years old who were treated at the dental clinics of San Gregorio de Portoviejo University, Manabí, Ecuador, in 2023. The sample included a total of 301 patients of both sexes with X-rays attached to their medical records. To review the radiographic images, a negatoscope was used where the degree of mineralization of the first permanent molars was evaluated according to the method proposed by Nolla (2). Each of the teeth 16, 26, 36, and 46 were assigned the corresponding stage, and with the sum of the values, the dental age estimated by the method was obtained.
The data obtained were recorded in the data collection form, and the following aspects were considered; sex, date of birth, date of radiographic taking, chronological age, and Nolla's stage of dental formation. To determine chronological age, the date of birth and the age at the time of radiographic recording were reviewed in the clinical history of each patient. However, for the Nolla method, a certain stage from 0 to 10 was established for each first permanent molar.

Once the information was collected, the data was imported into a Microsoft Office spreadsheet (Excel 2021) and then transported to the program (IBM SPSS version 26) (Statistical Package for the Social Sciences). For the analysis, descriptive statistics of the sociodemographic variables were applied; age and sex, as well as the frequency of Nolla stages by age in the first permanent molars, obtaining the percentages of these categories. Finally, the Pearson Chi-square test was used, achieving a level of significance lower than the 0,05 level (p=0,02), which indicated a significant association between chronological age and the stages of dental maturation of the first permanent molars.
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Ethical aspects.

This study was approved by the Human Research Ethics Committee (CEISH-Comité de Ética de Investigación en Seres Humanos) of the Technical University of Manabí, with the code (CEISH-UTM-EXT_24-04-05_MFFY). Likewise, it was based on to the established principles of the 1964 Helsinki Declaration, guaranteeing the right to privacy protection and confidentiality in data handling (12).

Results

The total sample was made up of 301 panoramic radiographs of pediatric dental patients aged 4 to 9 years, with a distribution of 172 females and 129 males. In both sexes, the age group with the highest percentage was 8-year-old children, followed by 9-year-old children. The age groups with the lowest percentage were 4 and 5 years old.

Table I. Distribution of the sample by age and sex

	SEX		
AGE	FEMALE	MALE	%
4	1	4	2
5	7	3	3
6	17	12	10
7	25	23	16
8	76	51	42
9	46	36	27
TOTAL%	57%	43%	100%

Table II shows the frequency of Nolla stages by age in the first permanent molars, ranging from stage 3 to stage 10, evaluating a total of 1.204 teeth. In all cases, teeth 16, 26, 36, and 46 presented the Nolla stage corresponding to the complete root with open apices (stage 9). Specifically, in tooth 16, this stage was more frequent at 8 years, with 49 cases, while in tooth 26, it predominated at 9 years in 47 cases. In tooth 36, stage 9 occurred most frequently at 8 years, in 79 cases, and in tooth 46, also at 8 years, with 76 cases. However, at the age of 4 years, a lower frequency of cases was observed.

Table II. Frequency of Nolla's stages by age in the first permanent molars.

DENTAL		NOLLA'S STAGES		NOLLA'S STAGES		NOLLA'S STAGES		NOLLA'S STAGES	
AGE	f	FM 16	%	FM 26	%	FM 36	%	FM46	%
4	5	NS 3	40	NS 4	40	NS 4	60	NS 5	60
5	10	NS 6	60	NS 6	60	NS 7	70	NS 7	70
6	29	NS 6	37,9	NS 6	34,5	NS 8	44,8	NS 8	41,4
7	48	NS 7	43,8	NS 7	41,7	NS 8	45,8	NS 9	47,9
8	127	NS 9	38,6	NS 9	37	NS 9	62,2	NS 9	59,8
9	82	NS 9	39	NS 9	42,7	NS 10	50	NS 10	51,2
TOTAL	301								

f= frequency; FM= First molar; NS= Nolla's stage

In Table III, Pearson's Chi-square test was applied to analyze the relationship between chronological age and dental age according to the Nolla stages. The results showed statistical significance since the p value (0,02) is less than 0,05. This suggests that chronological age significantly influences dental age using the Nolla method in the study population.

Tabla III. Chi-square test in relation to chronological age and Nolla´s stage of dental mineralization

	VALUE	df	ASYMPTOTIC SIGNIFICANCE (BILATERAL)
Pearson's chi-squared test	443,949[a]	75	0,000
Likelihood-ratio test	287,572	75	0,000
Linear-by-linear association	165,291	1	0,000
N. of valid cases	301		

a. 77 cells (80.2%) have expected a count of less than 5. The minimum expected count is 0,02.

Discussion

The evaluation of dental development through Nolla stages is considered an elementary factor in determining chronological age in pediatric dentistry, providing important information for correct diagnosis and treatment planning, allowing the identification of late or early maturation, and, likewise, understanding the formation of permanent dental (13),(14). However, the accuracy of the dental age estimation method can be influenced by

sample size, variability of age groups, statistical approaches, and their precision (15). As in other similar investigations, this research work is widely discussed in the literature showing its validity and usefulness in the dental field.

Of the 301 panoramic radiographs, the first permanent molars 16, 26, 36, and 46 were analyzed. It was evident that tooth 36 showed the highest frequency in stage 9 at the age of 8 years, with a prevalence of 62,2% and an absolute frequency of 79. This was followed by tooth 46, at the same age and stage, with 59,8% and a frequency of 76, which coincides with other investigations (16),(17). In a similar study, in which the first molars were analyzed to evaluate their dental maturation and development through the Nolla method according to age, it was found that tooth 26 showed the highest frequency in stage 8 (18).

However, in an investigation carried out on Korean children who visited the Yonsei University Dental Hospital, it was determined that Nolla stage 6 was present on tooth 16, corresponding to the complete formation of the crown, at the ages of 5 and 6 years (19). This result indicates that there could be differences in dental development between different populations.

Regarding the Pearson Chi-square statistical test with a 95% confidence interval, a significant relationship was found between chronological age and the stage of dental mineralization according to Nolla, with a value of (p=0,02), these results are consistent with other studies carried out where there is a significant association between these variables (20),(21),(22).

Also, a study that was developed at the Faculty of Pediatric Dentistry of Tokat Gaziosmanpaşa University shows a statistically significant relationship between chronological age and the Nolla mineralization stage (p = 0,02) (23). Furthermore, in research carried out in the KwaZulu-Natal region of South Africa, a highly significant difference was found between the chronological age and the dental age of Nolla, giving a value (p = <0,001) (24).

Conclusion

The results indicate that chronological age has a considerable impact on dental mineralization in pediatric dental patients aged 4 to 9 years, and that Nolla stages are a valid tool for assessing dental maturity in this population.

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This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflict of interest

The authors of this manuscript have no conflicts of interest to declare.

Regulatory statement

This study was conducted following all provisions of the guidelines and policies of the local human subjects oversight committee of the Human Research Ethics Committee (CEISH) of the Technical University of Manabí. This study protocol was reviewed and approved by [Human Research Ethics Committee (CEISH) of the Technical University of Manabí], approval number [CEISH-UTM-EXT_24-04-05_MFFY]

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