

## Evaluation of third molar development in the estimation of chronological age



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### ABSTRACT

The purpose of this study was to evaluate the correlation between chronological age and the degree of third molar mineralization by Demirjian's developmental stages (Demirjian et al., 1973) using panoramic radiography. From a total of 11,396 digital panoramic radiographs of patients from three oral radiology private clinics from the northeast region of Brazil, obtained from January to June 2009, 2097 radiographic images from patients aged between 6 and 22 years were selected. The images were analyzed individually by two observers using a 21-inch computer screen and Windows Picture and Fax Viewer. Reliability was achieved by intra- and interobserver evaluation, using the Kappa test. Chronological age, calcification stage, gender and third molar were interrelated using a multiple linear regression model, considering age as a response variable. There was reliability with Demirjian et al.'s developmental stage assessment, displaying a significant relationship between mineralization stages and patients' age ( $P < 0.05$ ). There was no significant difference between the average age and the calcification stage taking gender and localization of the third molar into consideration. It is possible to estimate chronological age based on Demirjian's stage of a third molar, regardless of gender and location.

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## 1. Introduction

Forensic odontology has reliably been using third molar mineralization to estimate chronological age as an auxiliary parameter in the identification of corpses and human remains. Furthermore, this process can be used as an additional tool to distinguish between young people and adults for criminal purposes [1–3]. Radiographic images are frequently used in the age estimation process as an essential tool in human identification in forensics [4].

Teeth have specific characteristics consistent with the many phases of human development [5]. Because they go through different morphological stages, changes in mineralization of dental

tissues occur gradually and can be less affected by changes in the endocrine and nutritional systems than other criteria for maturity estimation [6].

Classification methods for the cycles of dental formation are based on radiographic analysis and teeth codification according to the stages defined by Nolla in 1960 [7] or Demirjian et al. in 1973 [8]. Most studies are based on analysis of panoramic radiographs because of their relative practicality and they provide an overview of the maxillomandibular complex, alveolar region and adjacent structures [1–3,6,9–22].

In a retrospective evaluation using MEDLINE and third molar, radiography and age estimation by teeth as descriptors, 101 articles were found. Of those, 39 based their analysis on Demirjian's method of classification or adaptations of it. Few studies in Brazil were based on this parameter [20,23]; Nolla's [7] classification [10,12,16,24,25] and Nicodemo's [26] classification [6,27,28] were more commonly studied in Brazil.

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Therefore, the aim of this study was to evaluate the correlation between chronological age and mineralization of third molars using the eight developmental stages (A–H) described by Demirjian et al. [8] in a Brazilian population sample.

## 2. Materials and methods

The present study was approved by the Ethics Committee of the Center of Health Science, Federal University of Paraíba (UFPB), under protocol no. 106/09.

A total of 11,396 digital panoramic radiographs of patients who attended three private dental radiology services in Recife, PE, João Pessoa, PB, and Fortaleza, CE, Brazil, obtained from January to June 2009 were used in this study. The sample comprised 2097 images from patients aged between 6 and 22 years of any ethnicity and any gender. Radiographs that displayed a lack of any permanent teeth, signs of dental development disorders, and lesions of any kind in the third molar region were excluded.

All panoramic radiographies were obtained using a charged coupled device direct radiography system at a resolution of 300 DPI (dots per inch). Age and gender were recorded on an evaluation sheet for each patient. The panoramic images were exported in tagged image file format (TIFF) and codified so that the gender and age could not be identified by the observers during the evaluation.

All observations took place in a quiet, windowless room with dimmed lighting. Digital images were viewed by the observers on a 21-inch monitor in random order using Windows Picture and Fax Viewer software (Microsoft Word, Louwesweg, Amsterdam, the Netherlands). The images were assessed twice by the observers. The minimum interval between the evaluations of the same patient was 30 days. The observers could use the zoom tool up to three times to determine the calcification stage according to the mineralization diagrams proposed by Demirjian et al. [8]. Verbal and written instructions were made available to the observers. Depending on the grade of development of all third molars, a score on a scale from A to H was assigned: (A) calcification of certain occlusal points without fusion; (B) fusion of the occlusal points of mineralization; (C) end of the formation of enamel and beginning of the deposition of dentine; (D) formation of the crown-enamel cement junction; (E) the longitude of the root shorter than the latitude of the crown; (F) the longitude of the root equal to or greater than that of the crown; (G) the growth of the root stopped and the apical orifice remains open; (H) closure of the apical orifice. All third molars suitable for evaluation, irrespective of the direction of eruption, were evaluated in the study. This was

performed using direct comparison of the appearance of each third molar with Demirjian et al.'s diagrams (Fig. 1). In cases where there was doubt between two stages of mineralization, the observers determined the least developed stage. Each stage of mineralization was given a score ranging from 0 (A stage) to 7 (H stage) for statistical analysis. This score provided an estimate of age that was converted directly into dental age as per the standard table given or substituted in the regression formula for maturity.

### 2.1. Data analysis

The data collected regarding the Demirjian developmental stage of each tooth was recorded along with the patient's age. Inter- and intraobserver reliability was assessed by Cohen's Kappa test using the data collected regarding Demirjian's stage classification of the third molars. The relationship between age, calcification stage, and tooth was adjusted using a multiple linear regression model, where age was a response variable. Repeated measures analysis of variance (ANOVA) was used for assessment of average age in relation to calcification stages, gender and dental elements. The significance level was 0.05 (or 5%). Stata 9.2 and Minitab 15 software were used for the statistical analysis.

## 3. Results

The sample comprised 2097 digital panoramic radiographic images, of which 1150 (54.8%) belonged to female patients. The age ranged from 6 to 22 years; the average age  $\pm$  standard deviation was  $15.0 \pm 3.4$  years.

Table 1 shows the results of the Kappa test for the intra- and interobserver evaluations. There was agreement ranging from good to excellent in both evaluations.

Table 2 shows the results of adjustments for age using multiple linear regression models for age, considering Demirjian stage, gender and the interaction between gender and Demirjian stage for each third molar as the predictive variables.

With these adjusted models, the average age estimates and the corresponding interval of trust were obtained according to the location of the tooth Demirjian stage and gender (Tables 3 and 4).

Regression lines with the correlation between different Demirjian stages and the patient's age according to the location of each third molar are represented in Fig. 2. Fig. 3 shows the correlation between Demirjian stage and chronological age according to the patient's gender.

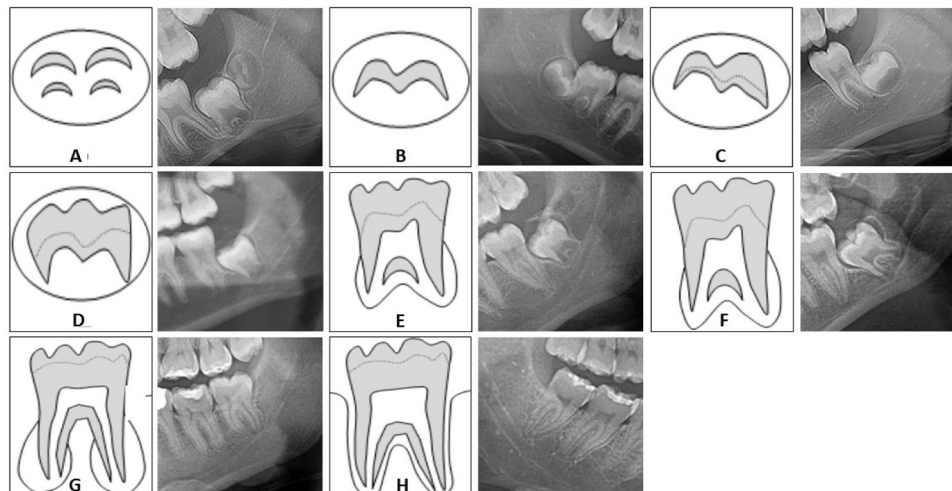


Fig. 1. Representation of Demirjian's eight stage diagram of mineralization.

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