



## Third mandibular molar radiological development as an indicator of chronological age in a European population

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### Abstract

Assessing biological age in the youth nearby legal age has always represented a stimulating issue for the Italian forensic scientist as far as he deals with matter of imputability and legal or illegal immigration of uncertain age subjects.

Since any method of evaluation should of course be accurate, not invasive, reproducible and, as possible, easily exploitable, radiological investigation of age dependent features is the most appropriate instrument to the purpose.

Dental development is slower and delayed compared with skeletal bone one, occurring according to a known, regular pattern from whose evaluation a biological age can be assessed with a reasonably restricted span for a certain radiological image.

This is the assumption which inspired since 1941 (Schour e Massler) so many anthropologists and forensic and clinic odontologist in investigating biological age by the study of radiological dental morphology.

Demirjian and Goldstein [New systems for dental maturity based on seven and four teeth, *Ann. Hum. Biol.* 3 (1976) 411–421] obtained no differences between two groups of subjects whose age was estimated by the evaluation of 14 teeth in one case and 7 teeth in another, the last being greatly simpler.

Afterwards, Thorson (1991), Mincer et al. [The A.B.F.O. study of third molar development and its use as estimator of chronological age, *J. Forensic Sci.* 38 (1993) 379], Solari and Abramovitz [The accuracy and precision of third molar development as an indicator of chronological age in Hispanic, *J. Forensic Sci.* (3) (2002) 531–535] and then Prieto Carrero [Evaluation of Chronological Age Based on Third Molar Development in the Spanish Population, *Atti del XIX Congresso IALM, Milano, 2003*], developed a method based on the evaluation of the radiological development of the alone third molar, according to Demirjian's schematic definitions of crown and root formation.

Eight stages of development of the third molar are defined from the time of mineralization appearance of the cusp tips up to complete closing of the apexes.

In order to achieve greater precision in discriminating stages F and G, Solari added two stages (F1 and G1), determining 10 stages of maturation of root and crown.

Prieto tested the accuracy and precision of this method by the evaluation of about 1300 orthopantomographs of juveniles and young Spanish adults of known age, divided for gender.

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We analyzed a total of 400 orthopantomograms of young Spanish dental patients to evaluate the chronology of the right mandibular third molar development and to assess its correlation with the biological age of the tested. Biological age is attributed with a maximum standard deviation of 2.47 from the mean in the eight stages outline.

The greatest limit of the method seems to be the operator experience in determining the dental stage of development.

We think that age data coming from such evaluation method should be clearly explained to the magistrate in their true statistical significance and limits.

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## 1. Introduction

To assess the biological age of a subject around the age of majority has always been a challenging issue for an Italian forensic doctor because of the implications on criminal liability (art. 85 of the criminal code), or to establish the age, when unknown or uncertain, of people under criminal prosecution or to assess the age of immigrants, without documents, for the purposes of legalizing their position and allow members of their family to reunite, in compliance with Legislative Decree 286/98.

In Forensic Medicine, the importance of biological age – in relation to Italian law – focuses on the age of majority and on 14 years of age.

The analysis of carpus ossification nuclei [1], a method commonly used for clinical-diagnostic purposes, among others, is well-grounded and internationally accepted when juveniles of about 14 are involved, but when dealing with subjects of around 18, the method is no longer valid because skeletal maturity virtually nullifies any detectable modification and no assessment can be made correctly.

At such an age, the study of cartilage ossification is scarcely relevant, although some information may be derived from the study of the shoulder joint, where bone development occurs later than for other bones. Dental development is delayed and slower than skeletal development, but nevertheless follows a regular pattern, which is radiologically assessable.

Biological age investigation based on the morphoradiological study of dental elements is a non-invasive examination and consequently applicable to living people; it can be performed simply, reproduced and is not very expensive. The practice began last century [2] and was initially oriented/applied to the study of the whole arc of the mandible [3], subsequently focusing on selected elements [4], finally reaching the conclusion that the third molar [5–7] should be considered the most significant indicator of maturity, since it is the last element to complete its development.

The aim of this study is to assess the chronological development of the third molar in a group of young Caucasian between 14 and 25 years of age in order to establish a possible utilisation of data for the diagnosis of age of majority.

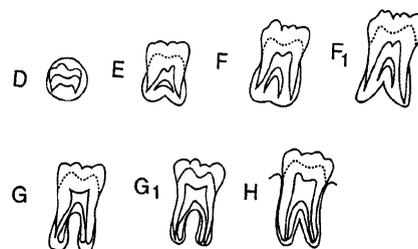
## 2. Materials and methods

In co-operation with the Dental Department of the University of Valencia, the study examined a sample of 400 orthopantomographs (OPT), gathered in a file, referred to 200 males and 200 females of Spanish nationality, avoiding foreign surnames and ambiguous cases. The material has been gathered during a period from 14.5 to 25 years of age.

Examination and classification covered the development phase of the third right mandibular molar and when such dental element was not present or radiologically misplaced or affected by a disease the contra lateral molar was considered, given the fact that dental events generally take place within a certain portion of the mandible within a limited period of time, without significant error in 27 cases in which the procedure became necessary, whilst in 56 OPT, projection errors made classification impossible.

An X-ray of the subject is compared to a series of standard images in order to identify the closest correspondence in terms of ageing, using a system with eight stages (A–H) of the formation of the tooth, from the onset of initial calcification of the crown to the closure of the apex, as defined by Demirjian and colleagues, and then considering more detailed evidence of the stages – F1 and G1, as described by Solari and colleagues, in order to fine-tune the process.

The stages observed in the sample examined are shown below:



The average age of subjects at each stage was considered, comparing the data with other studies and the method was assessed for subjects above the age of majority, making distinctions between men and women.

Table 1  
Staging according to Demirjian

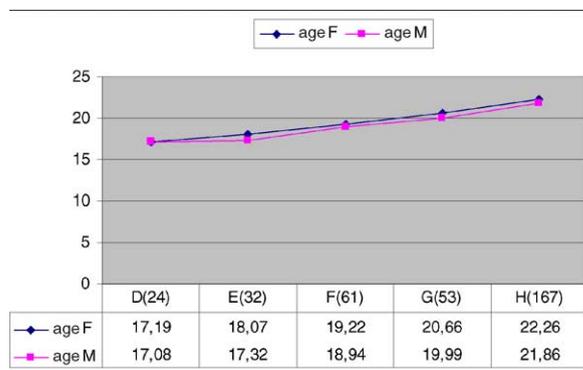
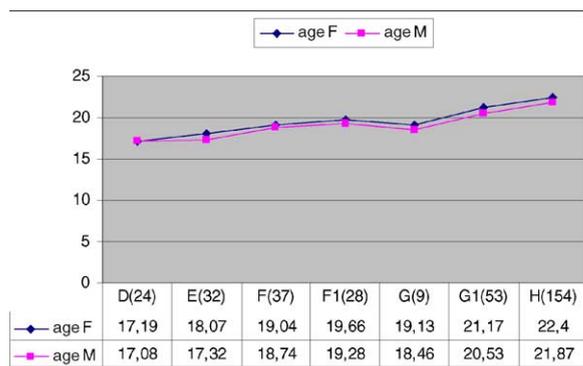


Table 2  
Staging according to Solari



Mean ages were calculated with standard deviations and the percentage distribution for each stage. For each stage, the likelihood that the individual was over 18 was calculated.

### 3. Results

The results for mean ages are set out in Tables 1–3.

### 4. Discussion

The results show that the stage of development of the third molar has a practically linear relation to the age of the subject, whether man or woman, the latter developing a little later, as literature has stated on many occasions [8,9].

In our sample, staging by Solari led to a redistribution of subjects previously allocated to the final stages of development, with a drastic reduction of cases classified as G (nine cases), due to the presence of a particularly mature person

Table 3  
Likelihood that the subject is over 18 years stage H

	Staging according to Demirjian	Staging according to Solari
F (%)	98.61	100
M (%)	96.84	96.70

for his age, which tipped the average towards a lower figure than expected.

The method involves some degree of inaccuracy due to the observer, the difficulties of identifying sub-stages F1 and G1 compared to stages F, G and H, which did not make our diagnosis any more accurate, leading us to prefer the Demirjian method.

The statistical calculation of probability that a subject at the H stage for the third molar – i.e. when the apex is complete – was 100% for women and close to 100% for men. This makes the method very useful in forensic applications, where other evidence from skeletal development is insufficient to determine the age of maturity.

The likelihood that subjects in the F and G stages are over 18 is significant for both men and women. In these cases, other investigations of biological age should be carried out.

### 5. Conclusions

In our opinion, the diagnosis of biological age in subjects around the age of 18 can be made relatively accurately by radiological examination of the development of the third mandibular molar and should be the preferential method in forensic applications.

### Acknowledgements

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