



Age estimation in Portuguese population: The application of the London atlas of tooth development and eruption



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ABSTRACT

Chronological age estimation from the dental parameters is becoming increasingly important. The London atlas of tooth development is the most recent developed method and represents a modification of the previous older methods.

The aim of this study was to evaluate the accuracy of the London atlas for the dental age estimation in the Portuguese population.

The study sample included 736 radiographic images (498 females and 238 males) of Portuguese origin, patients of Dental Clinic of Superior Institute of Health Sciences Egas Moniz and Dental Medicine Faculty, University of Lisbon. The age range of the individuals was between 3 and 24 years. Estimated age was compared with the chronological age using the paired t-test.

The results showed that there was no statistically significant difference between left and right side of the jaw ($p > 0.05$). Both sides showed an average overestimation of age by one month approximately. Moreover, the significant difference between chronological and estimated age was not observed in the females. However, the significant difference was observed in a sample coming from males (right: $p = 0.008$; left: $p = 0.003$).

Our results showed that the London atlas can be potentially used as a tool for age estimation. However, the difference between sexes clearly suggests that separate charts should be made for each sex. Further studies, which will have as a final goal the development of a new method for age estimation using dental parameters, are needed.

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1. Introduction

Estimation of the chronological age in living or deceased individuals is becoming increasingly important in modern societies. In forensic science, age estimation is one of the main areas of research. The need for this specific branch of forensic science can be explained by the constant increase of the unidentified individuals due to the worldwide conflicts or special requirements from the judicial bodies in cases of the unknown age of the

individuals [1]. In the past several years an emerging problem of illegal immigration hit Europe, due to the global changes in politics and influenced massive migrations around the world. Immigrants usually do not have any identification documents in their possession and it is necessary to know their exact age in order for them to apply for asylum. Moreover, the increase of sub-adult delinquents in different European countries raises the awareness that the age estimation is required to determine the criminal responsibility of the perpetrator [2–4]. Based on the Portuguese legislation (19th article of the Portuguese Penal Code [5]), persons aged over 16 are considered imputable. In this age range, it is considered to have more cases of forensic age estimation in living persons. Furthermore, this age is closely related to numerous legal implications, if Portuguese judicial system is taken into account.

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The especially interesting and vulnerable category of illegal immigrants is “unaccompanied minors”. Based on the definition from the European Commission (EC), the unaccompanied minors (UAMs) are children coming from third world countries who arrive on the territory of an European Union (EU) Member state unaccompanied by an adult responsible for them or those who are left unaccompanied after they have entered the territory of the Member State [6]. Besides the regulations coming from the EC, every member state may have different national legislation on this matter.

When it comes to Portugal, in the past year (2015) there was an immense increase in asylum seekers, a total of 872 persons. That was 97% higher than the asylum requests that were submitted in 2014. The number of unaccompanied minors in these two years has drastically increased, from only 16 in 2014 to 57 in 2015 [7,8]. The body that is dealing with the asylum requests in Portugal is Aliens and Border Service (SEF) and on their request, the National Institute of Legal Medicine and Forensic Sciences (INMLCF) conducts an age estimation of the individual. The results of the analysis are crucial because they influence the future outcome of the asylum seeker's application, by determining whether the applicant will be treated as an adult or will be offered protected child status. Furthermore, a uniformity on the level of EU Member states is needed in order to overcome ethical concerns regarding age estimation in minors [9].

There are several ways in which the age of the individual can be estimated. Based on the recommendations of the Study Group on Forensic Age Diagnostics (AGFAD), each age estimation process should include three obligatory steps: physical examination, an X-ray of the left hand and the dental evaluation using the orthopantomographic image [3]. Although the combination of these methods gives the best results, the age estimation using the dental parameters gives more reliable results compared to the estimation from the skeletal development [9]. This is especially noticed in individuals, children and adolescents, where the development is still ongoing [12]. Most of the methods for age estimation using teeth are based on the rate of tooth development and eruption [11–16]. These original studies served as the starting point for many types of research that evaluated the accuracy and applicability of these methods [9,17–22]. However, there is a uniform consensus that the method has to show a certain amount of accuracy in order to be considered valid in legal cases [23,24]. Moreover, several authors emphasized the need for developing the universal system that can be used in dental age estimation [16,25,26]. The estimation of age in Portugal is based on the aforementioned methods, which were published for other populations. In order to comply with the Portuguese legislation, these methods have to be tested on the sample of Portuguese population [28].

Thus, the aim of this study was to evaluate the use of the London atlas on a sample of the sub-adult Portuguese population and show whether it is possible to use this method in the chronological age using the dental parameters. Moreover, the study has evaluated if there are significant differences between chronological and estimated ages in the population if there are significant differences in age estimation between sexes and finally, if there is a significant difference between age estimation on the left and on the right side of the human jaw.

2. Material and methods

In this study, 736 digital orthopantomograms were analyzed, 498 females and 238 males. The X-rays were collected from the dental clinics of two universities in Portugal, Dental Faculty University of Lisbon (FMDUL) and Superior Institute of Health

Sciences Egas Moniz (ISCSEM). The research was approved by the ethical and scientific committees of both institutions.

The whole sample was divided into two groups, based on the age of the individual and based on the requirements of the atlas. The first group was consisted of the individuals below 16 years of age and the inclusion criteria for this group were: *the presence of all mineralized permanent teeth or in phase of mineralization, absence of dental pathology in pulp canal and/or in periapical region, absence of extensive restorations and/or endodontic treatment, absence of trauma in the phase of tooth development, absence of impacted teeth, absence of orthodontic treatment and the absence of dental anomalies.*

The second group consisted of the individuals above 16 years of age and the inclusion criteria for this group were based on the third molars: *the presence of all four mineralized third molars or in phase of mineralization, absence of dental pathology in pulp canal and/or in periapical region on the third molars, absence of extensive restorations and/or endodontic treatment of the third molars, absence of trauma in the in the phase of development of the third molars, absence of impacted third molars, absence of orthodontic treatment and absence of dental anomalies in third molars.*

Since the radiograms were an integral part of the patient record, the author noted only sex, date of birth (DoB) and date of radiography (DoR). The radiograms were assigned with an individual number, which was the different from the protocol number, in order to ensure the confidentiality of data. The data was inserted in the Microsoft Office Excel 2013[®]. Chronological age was calculated using the simple formula from DoB and DoR. All the data was destroyed at the end of the research.

Every radiographic image was analyzed using the Adobe Photoshop[®] CS6 version 13.0 and was identified with the number of the study. All the radiographic images were processed and analyzed by the single observer (author). A special form for this study was made using the Microsoft Office Word 2013[®], which was used to enter the data from the radiographic analysis. Every grade for the development/eruption of the tooth assigned by the author was recorded in the form, with the final estimation of age for the left and the right side of the jaw. Grades were defined by the London atlas of tooth development [16,27,29]. During the analysis, the author was not aware of the chronological age of the individuals.

Intra-class correlation (ICC) was calculated in order to evaluate intra-observer reliability. The repeated analysis of radiograms was done after a month and a half from the first analysis. In the second run, the author reanalyzed 30% of the original sample, a total of 220 radiograms. During this analysis, the author was not aware of the data from the first one. The sample selection was on a random basis.

The statistical analysis of the data was done using the IBM SPSS[®] version 23.0 software. The program was used to make a datasheet, to enter, check and analyze the data. For all tests, the significance level was 5% ($\alpha = 0.05$).

3. Results

From the 736 radiograms, 68% (N = 498) corresponds to females, while 32% (N = 238) corresponds to males. The biggest number of individuals was in an age group of 14, 15 and 22 years (Table 1).

The ICC was evaluated for the right and the left side. The values of 0.998 and 0.997 correspond to an almost perfect agreement. There was no statistically significant difference between the two observations.

A comparison between the right and the left side showed that in 91.6% individuals the chronological and estimated age were the same. In only one individual the estimation was greater than the real age at 48 months (Table 2). As it can be observed in Fig. 1, the differences between the right and the left side are not concentrated

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