Forensic Anthropology Population Data

Assessment of legal adult age of 18 by measurement of open apices of the third molars: Study on the Albanian sample

Roberto Cameriere [a], Valeria Santoro [b], Roberta Roca [b], Piercarlo Lozito [b], Francesco Introna [b], Mariano Cingolani [c], Ivan Galić [d,*], Luigi Ferrante [a,e]

[a] AgEstimation Project, Institute of Legal Medicine, Macerata, Italy
[b] Section of Legal Medicine, University of Bari, Bari, Italy
[c] Institute of Legal Medicine, Macerata, Italy
[d] Departments of Research in Biomedicine and Health and Dental Medicine, University of Split School of Medicine and University Hospital Centre Split, Croatia
[e] Department of Biomedical Science and Public Health, Faculty of Medicine, Polytechnic University of Marche, Ancona, Italy

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ABSTRACT

The third molar tooth is one of the few anatomical structures in development available for estimating the age of individuals in the late adolescence. This study tests the accuracy of Cameriere's cut-off value of the third molar index (I_{3M}) in assessing legal adult age of 18 years in an Albanian sample. For this purpose, a sample of orthopantomograms (OPTs) of 286 living subjects (152 female and 134 male) aged between 15 and 22 years was analyzed.

Intra-rater and inter-raters agreement of I_{3M} were 0.998 and 0.998, respectively and Cohen Kappa for intra-rater and inter-rater agreement in decision on adult or minor was 1.0 and 1.0, respectively. Age distribution gradually decreases as I_{3M} increases in both males and females. The mean age of females is higher than that of males when I_{3M} is between 0.04 and 0.08. Sensitivity test for males was 94.1%, with a 95% confidence interval (95% CI) 85.6–98.4%, and specificity was 90.9% (95%CI 81.3–96.6%). The proportion of correctly classified individuals was 92.5%, with a 95%CI of (86.7%, 96.4%). For females, the sensitivity test was 75.4%, with a 95%CI of (63.1%, 85.2%) and specificity was 96.6%, with a 95%CI of (90.3%, 99.3%). The proportion of correctly classified individuals was 87.5%, with a 95%CI of (81.2%, 92.3%). The results indicate that Cameriere's cut-off value of the third molar index ($I_{3M} = 0.08$) is useful in discriminating between Albanian adults and juveniles, and encourage us to test its suitability for determining the adult age in individuals from other populations.

1. Introduction

Age estimation of individuals in the forensic context is necessary for both the dead and the living. For the dead person, it is mainly used to aid in the identification and creation of the biological profile which can then be compared with those of missing persons. For the living person, the aim of age estimation is to solve some medico-legal, civil or social problems concerning, for example, the real age of minors in cases of child adoption, properly treating unaccompanied minors who do not know their age or when there is a suspicion that the did not give their real age. Other reasons include asylum seeking procedures, assessment of the capability of being imputable, prosecuting pedophilia, child pornography and, for adults, different civil matters such as pensionable age and similar questions for individuals without valid documents of identification [1–4].

In particular, the assessment of biological age of a living subject around the legal cut off age for adulthood became a serious challenge for medical or dental forensic experts in Italy, mostly because of implications of criminal liability of the subject in proceedings, and also for other purposes, as noted above.

In the European Union (EU), the need for accurate age estimation techniques has never been greater than in the last two decades. This is partly due to armed conflicts within the subjects' native countries, resulting in an increased number of immigrants and asylum-seekers in EU. In cases such as these, a refugee's birth might never have been registered, and identity documents are often never even issued [1]. One of the criteria for having asylum granted is often being a minor [5].

* Corresponding author at: Departments of Research in Biomedicine and Health and Dental Medicine, School of Medicine, University of Split and University Hospital Centre Split, Spinčićeva 1, Split 21000, Croatia. Tel.: +385 996964609.
E-mail address: igalic@mefst.hr (I. Galić).

Age estimation is also required during the procedure for adoption of children from countries where there is no legal procedure for the registration of birth [6–8]. In immature individuals, still in development, age can be estimated relatively accurately with various morphological or radiological methods. However, toward the end of skeletal growth and development, only a few age-dependent features remain for the age estimation by the morphological methods. These methods include an evaluation of the development of the bones of the hand and wrist, clavicles, knee, ribs, iliac crest, and third molar teeth [9–16]. When authorities, different institutions or courts are in doubt about the age of the specific person, particularly if the individual is suspected of criminal activity, age estimation is often requested from official forensic experts in order to determine whether individual will be treated as, child, juvenile or adult [7].

In Italy, the age of criminal and legal responsibility is the 14 years. If person between age 14 and 18 would be charged with a crime, subject would be tried in the juvenile court. If a juvenile is convicted, he or she faces the possibility of serving time in a detention center designated for non-adults. At the age of 18 years, a person is considered to be an adult, and would therefore be judged according to general criminal laws [17].

The criteria for age estimation of the living individuals in criminal proceeding were presented and published by the Study Group on Forensic Age Diagnostics of the German Society of Legal Medicine (AGFAD), with special attention to sensitive legal and ethical implications. The AGFAD proposed guidelines for age estimation in the living, with procedures which include a physical examination with determination of anthropometric measures, inspection of sexual maturation and identification of any relevant developmental disorder. Examination of skeletal development include hand and wrist and if their maturation is completed, additional clavicles examination. Dental examinations include evaluation of dental status and additional X-ray analysis of the teeth, mostly using orthopantomograms (OPT) [18,19]. Different dental age estimation methods were published and tested, and they are differentiated according the age range of the evaluated individuals, using developmental or regressive changes on the teeth [2]. Most used method, based on the evaluation of the mineralization of selected number of teeth, is Demirjian staging system (DSS) that uses eight developmental stages (A–H) [20,21]. Age estimation is very effective by evaluation of mineralization of permanent teeth until the age of 12–14, when mineralization of the second molars finishes [22–26]. The assessment of development of the third molars is possible for individuals from 14 years up to 23 years of age, when their mineralization is completed in most healthy individuals [27].

The assessment of whether a person is an adult or not, is a constant challenge for forensic science, and every improvement of available or introductions of new, reliable methods is welcome. According to literature, Mincer et al. [28] was the first to study the third molars in determining whether an individual was an adult or minor by using DSS. Cameriere et al. [29] published a method for the discrimination between adults or minor, based on the correlation between the age and the normalized measures of the open apices and height of the third molar or the third molar maturity index (I_{3M}). The method was based on Italian sample and was particularly developed to more accurately classify minors. Other study by De Luca et al. [30] showed on different Italian sample of 397 adolescent and adults between 13 and 24 from Milan region, high performance of the accurately classification of the individuals when I_{3M} value of 0.08 was used.

According to the 2013 annual report of the changes in migrations and related polices in the Organization for Economic Cooperation and Development (OECD) countries, permanent immigration in Italy still remains at high level and foreign residents increased to 9% of the entire registered Italian population in 2011 [31]. Italy is specially affected in 2011 when landing of illegal immigrants increased drastically from under four and half thousands in 2010 up to over sixty thousand in 2011, as a result of political conflicts and changes in some African countries, particularly in Libya and Tunisia [32]. According to the OECD report from 2012, stocks of foreign population by nationality in specific countries shows that immigrants from Albania represent second largest group with population of 483,000, between Romanian (969,000) and Moroccan (452,000) citizens at the end of 2010 [32]. Furthermore, about one third of Albanian population was estimated to be living abroad, mainly in Greece and Italy, and to a smaller degree in other EU countries (mainly in the UK and Germany) as well as USA, Canada and Australia [33]. The correlation between age and the development of wisdom teeth in Albanians has not been assessed before, although Albanian immigrants and their families in Italy and EU are an important group to which the dental records, including OPT, can be reached for study. Therefore, the objective of the study was to test the applicability of the Cameriere's third molar index value of 0.08 for discriminating adult or minor age in Albanian sample of young adults.

2. Materials and methods

2.1. Subjects and materials

This is cross-sectional study based on the evaluation of 298 OPTs collected from four Albanian private dental clinics during 2012 and 2013 years. The study was conducted in accordance to the ethical standards laid down by the Declaration of Helsinki [34]. Selection criteria included the following: Albanian origin; age between 15 and 22 years; all teeth in the right lower jaw present; no obvious dental pathology on panoramic radiology related to the right lower jaw. Exclusion criteria included the following: subjects of unknown dates of birth; OPTs showing no lower right third molar; image deformity affecting third molars. A total of 12 (4.2%) OPTs were excluded from the considered sample, leaving OPTs of 286 Albanian individuals (134 boys and 152 girls) in this study. Age distribution is shown in Table 1.

All OPTs were recorded as computer files in JPG format in the resolution of 300 dpi. The digital images were examined by using the software package (Adobe Photoshop® CS4, Adobe Systems Inc., San Jose, CA). The right lower third molars were evaluated. The I_{3M} index of each evaluated third molar was performed according to the Cameriere et al. [29] method. Briefly, if the apices of the third molar are complete in maturation, i.e., the apical ends of the roots are completely closed, then $I_{3M} = 0$. Otherwise, I_{3M} is the result of proportion of the sum of the digital projections on OPTs of the width of the root in single-rooted or of the inner margins of both the open apices in multi-rooted teeth, and tooth length. Usage and determination of I_{3M} allows the use of a single predicting variable that is obtained by normalizing the measured values of the width

Table 1
Sample of panoramic radiographs from Albania according to sex and age categories.

Age (years)	Females	Males	Total
15	21	14	35
16	33	26	59
17	33	26	59
18	16	10	26
19	15	13	28
20	10	17	27
21	17	18	35
22	7	10	17
Total	152	134	286