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Age estimation among Brazilians: Younger or older than 18?

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ABSTRACT

The age estimation of living or dead individuals is an important part of forensic science because it can be used in various situations, including mass disasters, or for civil or criminal reasons, such as adoption or asylum. Teeth play a major role in this context because they are more resistant than bones in extreme environmental conditions and their development is hardly affected by exogenous or endogenous factors. Because the third molars (3rdM) are still in development from the age of 14, they are useful for determining whether an individual has reached the legal age of 18 years. This study aims to verify the method of Cameriere et al. (2008) in Brazil to discriminate whether an individual is under or over 18 years from the maturity index of the 3rdM (I3m). The analysis of 444 panoramic radiographs resulted in a sensitivity of 78.3%, a specificity of 85.1% and a correct classification of 87%. Significant differences in sexual dimorphism in the early mineralization of males were found only for the average age with I3m $\geq$ 0.08, except for the range (0.7, 0.9). Due to the high miscegenation ratio of the Brazilian population the ancestry was not one of the studied variables. The method is suitable for estimating adulthood for forensic purposes in Brazil, although it must be applied carefully and judiciously. We recommend a combination of several methods that are available to increase accuracy as well as the establishment of different parameters that are likely to determine whether a person is more or less than 18 years of age, depending on the different legal requirements, whether civil or criminal.

1. Introduction

Forensic anthropology can refer to several areas related to human beings and with regard to legal issues.[1] In an anthropological analysis, an expert usually uses statistical parameters, to test the possible association among some qualitative and quantitative characteristics to a specific population group. This is important for the investigation of species, sex, phenotype, skin colour, age, height and weight.[1] Some studies highlight the origin of dead human beings; others have to address in vivo issues. Thus, some investigations included DNA analysis,[2] and innovative studies have used strontium and oxygen isotope analysis to study the geographic origin.[3]

Age estimation of living or dead individuals is continually necessary for forensic purposes, and the dental sciences can contribute in these situations. Many age estimation methods have been reported in the literature, and the dental characteristics, such as dentine, cementum and dental pulp, can contribute physiological and pathological information that could be associated with age. Some techniques require dental extraction to perform the analysis. Because these techniques would not be applicable in vivo, other techniques have been developed using X-rays.[4]

In a mass disaster, an accurate dental age estimation is helpful because it narrows the search for possible victims. Among living people, especially children and adolescents, age estimation is required for civil purposes, such as for adoption processes, or for criminal reasons to check whether the accused has reached legal majority[5]; in other circumstances, it would be necessary to perform

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age estimation when unattended young individuals ask for asylum (protection).[6]

Dental age estimation through the third molar (3^{rd}M) evaluation is of particular importance because they are the last teeth to develop[7] and they can offer information with regard to this critical age. Furthermore, in many countries, including Brazil, this age (18) represents the legal majority.[8]

An investigation performed by Cameriere et al.[9] verified the plausibility of dental age estimation using solely third molars among Caucasians. Until now, no data has used the technique in the Brazilian population. Therefore, the objective of this study was to ascertain the reliability of the method in the Brazilian population using the third molar maturity index.[9] Additionally, as a secondary objective, it is used to help to establish parameters to discriminate whether an individual in under or over 18 years old.

2. Materials and methods

A selection of 500 orthopantomographs (OPG) was performed in the cities of São Paulo and Brasília, both in Brazil. They were taken for therapeutic purposes in two large radiographic centres in these cities. After analysing the inclusion criteria, 444 OPG were selected (88.8% suitable), 205 from males and 239 from females, 14–22 years old (according to Table 1). The sample size calculation took into account an estimated correlation of 0.40, test power of 0.80 and significance of 0.05. The patients' identities were preserved, and the OPG were coded with numbers.

As in the original technique,[9] left lower third molars (LL3rdM), impacted or not, were included in the sample if the roots were visible. Due to the high miscegenation ratio of the Brazilian population the ancestry was not one of the studied variables.

To discriminate whether the individual was under or over 18 years old, Cameriere's et al. technique[9] verifies the root apex of the LL3rdM of each individual and establishes the third molar maturity index (I_{3m}): if the LL3^{rd}M presented completed root development (root apex closed), $I_{3m} = 0$; if the root apex was not completed, the I_{3m} was evaluated as being the sum of the distances of the inner sides of the open apexes (A + B) divided by the tooth length (C). According to Cameriere's cut-off value,[9] an individual is considered to be 18 years of age or older if the $I_{3m} < 0.08$. These measurements were balanced through division (A + B)/C, to consider the possible distortions among the OPG (Fig. 1).

The sensitivity of the test (i.e., the proportion of subjects older than or equal to 18 years of age who have $I_{3m} < 0.08$) and its specificity (i.e., the proportion of subjects younger than 18 years of age who have $I_{3m} \geq 0.08$) were evaluated, as well as the probability of being 18 years of age or older (when $I_{3m} < 0.08$).

The OPG were evaluated by two properly calibrated investigators using Adobe® Photoshop® CS5 software. In order to evaluate interobserver and intraobserver reliability by using the Kappa coefficient, two observers made measurements of 30 OPG and one of them made repeated measures of 10 OPG at an interval of 45 days. Since if was found a normal distribution, to compare the results between sexes Shapiro–Wilk test was used ($p < 0.05$). Linear regression was used, and all of the data were organized and analysed using STATA® 11.0 software.

The investigation was submitted to the University of São Paulo's School of Dentistry (FOUSP) Ethics Committee, and it was approved. All of the parameters with regard to the Helsinki Declaration were followed.

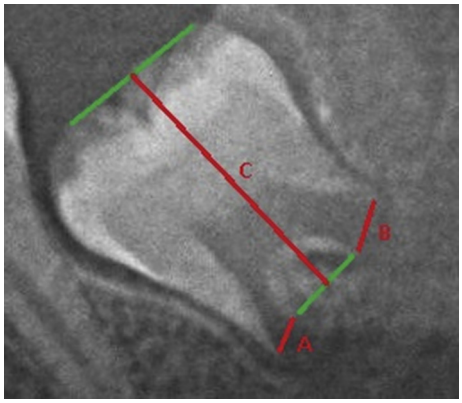

Fig. 1. Third molar measurements. Adapted from Cameriere et al.[9]

3. Results

Of the participants' images, 46.17% were from males and 53.83% were from females. Table 1 shows the number of OPG used, according to age and sex. The Kappa test showed an intra-observer agreement of 0.825 ($p = 0.001$) and inter-observer agreement of 0.873 ($p = 0.001$) (data not shown on the tables).

Table 2 shows in details the mean chronological age and the standard deviation classified as per the third molar maturity index. The mean age among females and males is 20.14 ± 1.74 years and 19.86 ± 1.57 years, respectively, when the I_{3M} ranges from 0.0 to 0.04.

Seventy five per cent of the individuals from both sexes and with an $I_{3M} < 0.04$ were found to be 19 years old or more, and 50% of the male and female individuals with I_{3M} ranging from 0.04 to 0.08 were 18 and 19 years of age, respectively (Table 2). Among the male subjects that had $I_{3M} \geq 0.08$, 75% were under 17 years of age. Among the female subjects, 75% of the samples that presented an

Table 1
Distribution of the Brazilian sample of orthopantomograms by sex and age categories.

Age category (years)	Male	Female	Total
14	26	23	49
15	30	27	57
16	27	26	53
17	30	35	65
18	15	26	41
19	27	22	49
20	21	25	46
21	16	32	48
22	13	23	36
Total	205	239	444

Table 2
Chronological age according to the third molar maturity index (I_3M): number of individuals (N) and Mean ± Standard Deviation (SD) of age distribution for each I_3M class by females and males.

I_{3M}	Female	Years	Male	Years	P[b]
	N	Mean ± SD	N	Mean ± SD	
[0.0, 0.04)	77 (64)[a]	20.14 ± 1.74	74 (63)[a]	19.86 ± 1.57	0.215
[0.04,0.08)	24	18.71 ± 1.78	20	18.00 ± 1.71	0.125
[0.08,0.3)	76	17.42 ± 2.20	61	16.47 ± 1.39	**0.002**[c]
[0.3,0.5)	22	16.06 ± 1.53	30	15.03 ± 1.03	**0.010**[c]
[0.5,0.7)	13	15.92 ± 1.32	5	14.06 ± 0.54	**0.001**[c]
[0.7,0.9)	13	15.69 ± 2.17	8	15.25 ± 1.83	0.624
[0.9,1.7)	14	15.28 ± 1.58	7	14.28 ± 0.48	**0.043**[c]

[a] Number of individuals with closed apex.
[b] Independent samples t-test.
[c] Statistically significant differences at a 95% of level of significance.