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Research Paper

Validation of Cameriere's medical-legal age estimation method using seconds premolars in a Portuguese population

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ABSTRACT

The goal of this project is to validate the Cameriere's method applied to the upper and lower second premolars in a Portuguese population, regarding the forensic estimate of age.

The applied sample consisted in 100 panoramic radiographs, of 60 males and 40 females, patients of the Faculty of Dental Medicine of the University of Lisbon, whose ages vary between 15 and 35 years old. Thus, a total of 400 teeth were investigated (200 upper second premolars and 200 lower second premolars). Each radiograph was analysed using draw and measurement tools featured in Adobe Photoshop, applying the Cameriere's method, and then the pulp/tooth ratio was computed for the 15, 25, 35 and 45 teeth. All data were statistically analysed with the SPSS program, using a significant level of 5%.

It was not observed any kind of relation, linear or not linear, between age and the pulp/tooth ratio. Linear regressions with considerably low values for the coefficient of determination were achieved, which indicates a low reliability for these models.

Accordingly, we conclude that the knowledge of the pulp/tooth ratio does not allow the identification of an individual based on the Cameriere's method, in the scope of a forensic age estimate applied to panoramic radiograph. Further investigations with larger samples and broader age groups are required in order to provide suitable evidence to the legal and social aspects of age estimate in Forensic Dentistry.

1. Introduction

Age estimation plays an important role in forensic medicine for either the living and the death. Regarding the living person, the main gold consists in solving medico-legal civil, penal and social problems, such as cases of adoption of minors or individuals without documents that could prove their age and that came to a foreign country with different jurisdiction. This kind of situations have been increasing in European countries, therefore is necessary to know if the individual should be treated as an adult or a child in criminal processes.[1–5]

The age estimation based on dental hard tissues is justified because these are the most lasting tissue of human body. They are elements with high resistance to the *post mortem* alterations, once they stay intact at a macroscopic, chemical and microbiologic level during long lasting terms. These tissues resist to high temperatures, trauma or severe decomposition. Besides, they are easily analysed when compared with osseous components.[6,7]

Several factors can be used to the age estimation regarding dental analysis, such as mineralization and dental eruption, analysis of the radiologic, biochemical and histological characteristics among others.[6,8]

The methods that are used in adult population can be clinical and radiographic methods.[9–14]

When using radiographic methods is possible to evaluate different characteristics like deposition of secondary dentin at the pulpal wall, which occurs due to the continuous production of the dentinal matrix by odontoblasts in a physiologic way. This manifests by the reduction of the pulpal chamber and therefore permits to estimate the age of a patient without having to use invasive methods.[10,15–17] In 2004, Cameriere et al. present a method using a ratio between the area of the

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pulp and the area of the tooth, using the upper right canine. In this study, Cameriere et al. used orthopantomography and measurements at two-dimensional, computed using computer software.[18]

The aim of this study is to evaluate the application of the above described method, in the Portuguese population, using the upper and lower second pre-molar in orthopantomography.

2. Materials and methods

2.1. Sample

The applied sample consists of 100 individuals between 15 and 35 years old, from both genders, born in Portugal, whom had an orthopantomography taken in Dental Medicine Faculty, University of Lisbon (See Fig. 1). To be included both upper and lower second pre-molars, both left and right, should be on a post-eruptive phase, absence of endodontic or restorative treatments, absence of caries, the teeth should not have morphology and position anomalies.

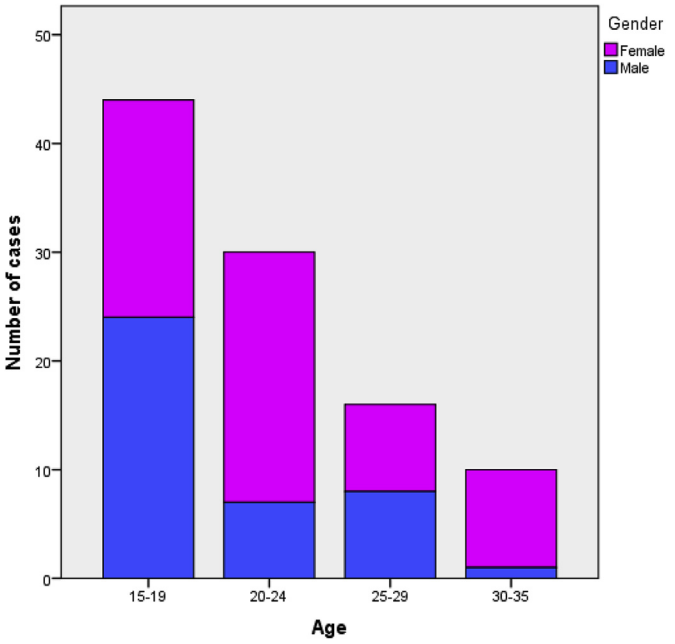

Fig. 1. – Distribution of the sample according to age and gender.

2.2. Methodology

Radiographic analysis was performed according to the measurements purposed by Cameriere et al.[18] using the computer software *Adobe Photoshop*®. All measurements of the tooth 15, 25, 35 and 45 (according to the Federation Dentaire International tooth numbering system) were made using at least 20 points to measure the tooth area and using at least 10 points to measure the pulp area.

The data were recorded in the computer software *Microsoft Excel*® and the ratio pulp/tooth was calculated.

2.3. Intra- and inter-observer calibrations

One observer collected all the data considering the upper pre-molars while another observer collected the data from the lower pre-molars. Moreover, in order to test the intra-observer variability, each observer repeated the measurements of 10% of the total sample (randomly selected), 3 months after the first measure.

In order to test the inter-observer variability the measurement of 10% of the total sample was performed by the other observer.

The inter- and intra-observer calibration were analysed by the intraclass correlation coefficient (ICC) based on the Fleiss classification.[19] Thus, the reliability is considered poor if ICC is lower than 0.40, satisfactory to good if ICC is between 0.40 and 0.75, and excellent if ICC is greater than 0.75.

2.4. Statistical analysis

The data considering tooth area and pulp area was first inserted in the *Microsoft Excel* program. Then, this same data was exported to the program IBM® *SPSS Statistics* 21 *(Statistical Package for the Social Sciences),* in which the statistical analysis was performed. A significance level of 5% was used in all the performed tests. This value indicates the probability to refuse the null hypothesis when this is true. A linear regression model was applied in order to obtain the age estimation according to gender and ratio pulp/tooth from all pre-molars. In addition, the analysis of covariance (ANCOVA) was applied to study possible interactions of gender in the linear regression model, considering age and pulp/tooth ratio as co-variables. The last two variables were analysed separately. To evaluate the regression estimates, a comparison between chronological age and estimated age was made using the coefficient of determination (R^2), the standard deviation of estimation (SE) and the mean absolute error (ME). These correspond to the three measures used by Cameriere et al.[20] Finally, the linear regression was evaluated considering each gender separately.

3. Results

The applied sample is consisted by 100 individuals with the distribution displayed in Table 1.

The ICC was used to evaluate the intra-observer variability. In each tooth under analysis, this coefficient was applied to the three measures of the study: tooth area, pulp area and ratio pulp/tooth. The lowest obtained value corresponds to the ratio pulp/tooth in the tooth 15 (0.298) which reveals a poor reliability in this measure. Nevertheless, all the remaining ICC values are greater than 0.6, which reveals a good or excellent reliability (cf. Table 2).

Similarly, the inter-observer variability was evaluated, where the ratio value of the tooth 15 also showed a low value (0.227) which means a poor reliability. Nevertheless, all the other values (cf. Table 3) reveal a good or excellent reliability.

In fact, both the tooth and the pulp area are measured twice, and the reliability of these measures is at least reasonable, being in most cases excellent. The pulp/tooth ratio is obtained by dividing these two measurements, thereby it amplifies the errors of their measurements and, therefore, has a lower reliability level. Even so, only in the tooth 15 the intra and inter-observer ICC values are effectively low.

3.1. Tooth 15

Concerning the tooth 15, no association between age and pulp/tooth ratio was found, as Fig. 2 shows.

Using the linear regression model to estimate the age as a function of the pulp/tooth ratio, the equation presented in Table 2 was obtained. This model presents a R^2 value of 0.043, SE = 5.186, ME = 4.1709,

Table 1
Sample distribution according to age and gender.

Age Gender	Number of orthopantomographies	
	Female	Male
[15–19] years old	20	24
[20–24] years old	23	7
[25–29] years old	8	8
[30–35] years old	9	1