Forensic Science International 201 (2010) 86–94

Contents lists available at ScienceDirect

Forensic Science International

journal homepage: www.elsevier.com/locate/forsciint

A comparative study of two different regression methods for radiographs in Polish youngsters estimating chronological age on third molars

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ARTICLE INFO

Article history:
Received 16 March 2010
Accepted 11 April 2010
Available online 7 May 2010

Keywords:
Gleiser and Hunt
Age estimation
Polish population
Third molar development
Orthopantomogram
Regression formulae

ABSTRACT

Aim: The aim of this study was to establish a third molar developmental database to model dental age of Polish youngsters, to investigate the rating level of the scores when dividing a year interval into a quarter of a year and to examine sex differences, left-right and upper-lower jaw asymmetry.
Material and methods: A cross-sectional sample of 1048 orthopantomograms of 644 females and 404 males aged between 12 and 26 years was investigated using the scoring system of Gleiser and Hunt modified by Köhler. Reference tables according to age were split in a whole year and in quarters of a year using descriptive statistics. The various developmental stages between males and females were analyzed with a paired *t*-test and the cusum method. Differences in mineralization between the quadrants were analyzed with a two-factor ANOVA and the Duncan post hoc test. The single quadratic and support vector regression were performed to describe the relationship between score and age.
Results: Dividing age classes in quarters of a year discriminated better between individuals provided that there is a sufficient sampling size for all age classes. The mineralization tempo occurred significantly at a faster rate in males. The maturational events in the upper arch developed significantly at earlier ages for both genders. Obtained chronological age had nearly the same standard error of estimate when calculated with both regression methods.
Discussion and conclusion: Comparing the results of the present study with those of other population groups suggests that there are differences in the ageing process of the wisdom tooth. This is the first database of Polish youngsters (15–24 years) with their respective regression equations to yield age estimations.

1. Introduction

Nowadays there is an increasing number of youngsters of approximately 18 years of age from different countries in the world with whom the Belgian judicial system has to deal. Judicial agencies retain forensic experts for age estimation of living adolescents and young adults with regard to criminal activities, asylum seekers, illegal immigrants and unaccompanied minors. The physiological age of a person is determined by the degree of maturation of different tissue systems. The recommendations of "The international interdisciplinary Study Group on Forensic Age Diagnostics" [1] state that dental age diagnosis includes a clinical dental observation and a radiological investigation. During the transitional period from adolescence to adulthood, the only dental biological variable consists of the crown and root development of the wisdom teeth [2–5]. Individuals of the same chronological age can demonstrate different degrees of dental maturation. Analyzing populations from various genetic backgrounds suggests substantial inter-population differences [6–31]. Until now no dental database is available of Polish youngsters originating from the same biological nationality. Besides those dental observations forensic age estimation should also include a physical inspection for signs of sexual maturity and any age-relevant developmental disorders, X-ray examination of the non-dominant hand and wrist [32–34] and eventually an X-ray examination of the medial clavicular epiphyseal cartilage [3,35–41]. The drawback of the ossification of ephiphysis and diaphysis in hand and wrist is that it is completed around the age of 18 while the third molar development continues until the early twenties.

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doi:10.1016/j.forsciint.2010.04.019

Research reports variable opinions about the role of gender [6,7,9,10,21,23,28,42]. In the literature contradiction exists whether there is a left-right asymmetry in the developmental formation of the wisdom teeth. Investigations shows that formation stages of the third molars are more advanced in the upper then in the lower jaw [6,7,9,10,23,31]. All these aforementioned statements claim that specific reference tables for both sexes are much-needed for estimating dental age of Polish individuals. To realize the present study orthopantomograms were gathered from Polish youngsters. Deciding on whether the person is an adolescent or an adult pertains to the judicial agencies. The task of the forensic expert includes the application of the latest and scientific based methods with appropriate statistical significance tests and their limits.

The aim of this paper was first to develop a database for Polish youngsters for dental age estimation. The second aim was to examine the degree of refinement in age estimation when delimiting age intervals to quarter of a year instead of year interval. Thirdly differences in genders and between quadrants were investigated. Finally besides the single quadratic regression analysis a second order polynomial regression model has been established to figure out the smallest standard error of estimate. Because the last technique has limitations in that the form of the model has to be fixed in advance, support vector regression (a black box method) was carried out as well.

2. Materials and methods

The sample consisted of orthopantomograms of Polish individuals of whom the age and sex were known. Some radiographs were digitally generated on a Orthorolix 9200 (Gendex, IL, USA). They were stored as TIF files. The remaining X-rays were acquired a on conventional manner using a Planmeca Proline XC (Planmeca Oy, Helsinki, Finland). The manually generated radiographs were scanned with a SNAP SCAN 1236 AFGA, Gevaert NV, Moortsel, Belgium. The scanned orthopantomograms were stored as JPEG file. All the X-rays were compiled in Lodz, Poland, from the Institute of Dentistry and private practices of two co-authors. The social background of the persons from the Institute was from lower and middle class. Those derived from the private practices came from wealthy families. Age was calculated on information from identity cards and converted to a decimal value. In total 1048 orthopantomograms were analyzed. The age ranged from 12.0 to 26.0 years. The data set included 644 females and 404 males with an original Polish background.

Table 1 displays the age and sex distribution and percentage of each population age category. Females represent a larger group than males because they are more concerned about their general health and dental status. The clinical records reported no history of medical disease or surgery that could affect the presence and development of third molars.

Radiological third molar development was scored following the 10 point scoring classification designed by Gleiser and Hunt [43] and modified by Köhler [44] (MG&H). On multi-rooted third molars the least developed side was scored. Image quality improving software tools were used to adjust gray scale, brightness and contrast or for conversion into a negative image.

For detection of intra-operator variation a repeated third molar scoring of 173 third molars was performed after one month and assessed with ANOVA.

The whole data set was elaborated using descriptive statistics. The different scores corresponding to the mean ages were devised for both genders and for the four quadrants.

An ANOVA was used to split out variation of scores between and within age categories (classes). Between class variability corresponded to the development stages depending on age.

This effect was minimal for within class variability. The share of each component depended on the test set up, i.e. on the selection of class limits. On the one hand the size of divided age classes should not be too broad as this means that the share of within class variation becomes too big, moreover a sufficient number of classes should be maintained. On the other hand the number of cases per class should be high enough for statistic reliability. Interclass comparison was performed between the age classes of one year and a quarter of a year (3 months). MG&H upper right for female has been chosen as an example. Each age class was described by its centre. This means that age class 18 included patients with ages between 17.5 and 18.5 (classes of 1 year) and between 17.875 and 18.125 (classes of a quarter of a year) excluding the lower limit and including the upper limit.

A paired *t*-test analyzed the differences in average scores per age classes between males and females and each quadrant. The assumed difference was zero. The cusum method [45,46] was used to analyze trends (development in age evolution) in

Table 1
Number of individuals categorized by age and gender.

Age	12–12.99	13–13.99	14–14.99	15–15.99	16–16.99	17–17.99	18–18.99	19–19.99	20–20.99	21–21.99	22–22.99	23–23.99	24–24.99	25–25.99	26–26.99
Male	0	1	3	40	53	51	42	35	40	35	39	41	20	3	1
Female	2	1	2	48	67	62	57	52	68	76	88	77	38	6	0
Total (%)	0.3	0.4	1	17.4	23.5	22.2	19.3	16.8	20.5	20.5	23.4	22.1	10.9	1.6	0.2