TECHNICAL NOTE

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Estimating Age of Majority on Third Molars Developmental Stages in Young Adults from Thailand Using a Modified Scoring Technique*

ABSTRACT: The aim of this study was to achieve a referral database for dental age estimation of unaccompanied minors of Thai nationality. A total of 1199 orthopantomograms were collected from original Thai women and men equally divided in age categories between 15 and 24 years. On the radiographs, the developmental stage of the third molars was scored applying a modified scoring technique. Inter- and intra-observer reliabilities were tested using kappa statistics. Correlation between the scores of all four wisdom teeth and left–right symmetry were evaluated with Pearson’s correlation coefficient. Student’s t-test on asymmetry was performed and regression formulas were calculated. The present database was the first to assemble third molar developmental scores on radiographs of Thai individuals and provides more appropriate dental age estimation of unaccompanied Thai minors. Future research on similar databases of different nationalities worldwide may expose ethnical influences on dental development.

KEYWORDS: forensic science, forensic odontology, age estimation, third molar development, ethnicity, Thailand

Dental age estimating methods employed in forensic odontology (1,2) are based on the changes in development (3–7), morphology (8–13), and biochemical (14–16) structure of teeth. Estimating the age of individuals or victims narrows the search for antemortem data during identification procedures of unknown remains (17,18), helps in establishing the difference between the juvenile and adult status of an individual in law cases (19–21), and aids persons without a birth certificate finding out their presumed age (22). Nowadays the judicial need to classify human beings lacking age information into the adult or juvenile group increases continually. Dental age estimation methods based on the analysis of the radiological determined developmental stages of third molars are the only tooth formation approaches for the judgment of this specific lifetime period (6,23). Although several population-specific dental age estimation researches on third molar development have been carried out, the collection of referral databases consisting of orthopantomograms of youngsters from the same national origin is strongly needed to ameliorate the accuracy of dental age estimation procedures. For consideration as a valuable age estimation database, it needs to contain large-sized samples of individuals with the same national or ethnic origin (24,25). The dental age estimation results obtained based on these databases have to be compared and integrated with the results collected by other methods, such as clinical observation (19), psycho-social age approach (26), evaluation of changes in secondary sex characteristics (27), epiphysial fusion of hand-wrist and sternoclavicular bones (28–31), changes in pubic symphysis (32) and anterior iliac crest (33), fusion of cranial sutures (34,35), cranial size changes (36), and occlusal tooth wear (11).

The aim of the present paper was the establishment of a radiological database of orthopantomograms from young adults with original Thai nationality so as to obtain regression formulas for age estimation of Thai individuals.

Materials and Methods

In this retrospective study, 1199 orthopantomograms were collected and selected at the Faculty of Dentistry, at the Chulalongkorn University (Bangkok, Thailand). The radiographs were digitally generated on a Kodak 8000C Digital Panoramic and Cephalometric System (Kodak Dental Systems, Atlanta, GA) and stored as TIF files in the period from 2005 to 2007. All the X-rays were captured from persons of Thai nationality and mongoloid ethnicity, with known chronological age at the moment of radiologic exposure. During the selection, only orthopantomograms of individuals with no medical history, no visible dental pathology on the radiographs, and at least one upper and one lower third molar present, were retained. The selected group was split into 613 women and 586 men, with each an age spread older than 15 years and younger than 24 years (Table 1).

All of the 4530 third molars visible on the orthopantomograms (Table 2) were observed and classified by the 10-point developmental scoring system as proposed by Gleiser and Hunt (37) and modified by Köhler et al. (38) (Fig. 1), and if necessary imported into Adobe® Photoshop® (Adobe Systems Incorporated, San José,
In case of doubt between two adjacent scoring stages, the concerned radiograph was integrated into Adobe®/Photoshop® to blow up the view, to select the mesial and distal enamel–cement junction of the involved wisdom tooth and the preceding second molar, to draw a line between them with the line tool, to determine a second line from the middle of the root end perpendicular to the first line detailing the length of the roots of both teeth, and to calculate their proportions (Fig. 2). On pluriradicular wisdom teeth the least developed root was examined.

All the samples were scored by one well-trained observer. With an interval of 30 days, 50 randomly chosen orthopantomograms were graded by a second examiner and rescored by the main one. To evaluate intra-observer bias, the absolute difference between the first and second scores of the main observer was calculated. Similar calculations were carried out for the scores of the main investigator and the second observer to check inter-observer agreements. Kappa statistics were employed for this purpose.

Results

Kappa statistics (Tables 3–6) revealed no significant intra- or inter-observer effects, which indicates that both observers were well calibrated.

In more than 98%, the differences between the developmental score of the left and the corresponding right third molar was less than or equal to 2 (Table 7). Student’s t-test for left and right asymmetry found for each jaw separately no significant difference, confirming left–right symmetrical third molar development (Table 8).

A high Pearson correlation coefficient was found between the right and left third molars in both of the jaws (Table 9), confirming the earlier symmetrical findings for females and males.

Multiple regression analysis resulted in regression formulas for both females and males enabling dental age estimations taking into account the developmental scores of third molars (Table 10).
account the high correlation between development of left and right third molars (Table 10).

For both the upper and lower jaw in a Thai population, wisdom teeth develop earlier in females than males up to at least 4 months for lower wisdom teeth, when the developmental stage equals 10.

Discussion

The increasing ease of worldwide traveling, the multiplying migrations, and the growing globalization of our societies urge the need to take into account, when performing dental age estimation, the origin or nationality of the individual at stake. Especially dental age estimation for determining the age of majority in young individuals should be based on data collected in the appropriate biological group. Several studies examined dental age estimation on different
populations (24,39–43), but the need for a uniform approach of data collection and analysis is increasing. In this study, the database and corresponding regression formulas provide forensic odontologists at any global location with a specific scientific tool when asked to provide judicial advice concerning the age of majority of a person from Thai origin. The same findings can be of great importance with regard to further investigations where equal data collection of populations with individuals of common nationality provide comparable materials and findings. It can offer directly scientific tools for examination of an individual out of a country with an existing dental developmental database (20). This way common practice of adjusting the few contemporary existing methods based on databases calibrated on a specific population, by increasing the standard deviation of their recommended regression formulas or by choosing wider confidence intervals can be excluded. Implicating unnecessary jurisdictional procedures can be avoided.

The integration of the radiographs in case of doubt in classifying its exact developmental score, into Adobe Photoshop® and the application of the prescribed protocol provides a more uniform scoring system (44). Although this system is not applicable before score 4 (beginning of root formation), this is of no significance when estimating age of majority. Indeed in this study, stages 1, 2 and 3, falling outside the age range of this research, were only scored in 1.28% of the cases. Direct impact of the new developed scoring modification was seen in a pilot set up. Two observers scored 30 orthopantomograms with all third molars present (minimal stage of development = score 4) twice, separate from each other and at different moments using for each scoring, the integration technique into Photoshop®. For intra- and inter-observer agreement, there was no difference in developmental score in more than 95% of the 120 evaluations.

The obtained regression formulas are independent of the left–right position of the evaluated third molar. In cases where at both sides, third molars in a different developmental stage are available, the choice between left and right is legally speaking the one providing an age result in favor of the examined person. In the same philosophy, during the data scoring, the least developed root of pluriradicular third molars was examined. Scientifically, the side providing the best fit is taken. This way, scoring teeth in unfavorable positions, in radiographic overlap with surrounding anatomical structures, or positioned out of the sharply depicted plane of the orthopantomogram can be avoided.

To obtain best age determination, all possible age estimation methods suitable for the particular case should be carried out (45). Each obtained outcome should be evaluated in function of its mutual weight and proportionally taken into account in the final report. Therefore, if possible all the regression formulas found in this study should be calculated and the mean reported as estimated dental age. In cases where the upper third molars are due to frequently appearing radiological overlap with maxillary tuberosa or the bottom of the maxillary sinus is more difficult to score, the formula only involving a lower wisdom tooth should be used. The higher difference and absolute difference between the first and second scores of the main observer in the upper jaw compared to the lower, point out this overall greater difficulty in scoring maxillary molars.

As four of the six acquired regression formulas are taking into account one tooth, in many cases age estimation could, certainly in certain forensic circumstances, where no panoramic radiographic unit is available, or in cases where maximum reduction of radio doses (46) has to be taken into consideration, for example when investigating a young pregnant woman, this can be useful. Moreover, forensic odontologists should always consider the ethical justification principles on radiological protection (47) and check the legality of taking radiographs for aging in their jurisdiction.

Conclusion

A referable database of developmental stages of third molars in a population of Thai individuals was established. For dental age estimation of these young adults, three regression formulas were obtained for both men and women.

Similar database collection of populations of varying origin may reveal in further studies more specific age-estimation techniques and possible differences or agreements in dental development between members of diverse nationalities or distinct ethnic groups.

References


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