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Radiological dental age estimation on third molars in south Indian population: correlation between five tooth staging methods

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ABSTRACT

The mineralization of third molar is one of the main criteria for radiological dental age estimation of living subjects .The ethnic populations residing in different countries have been insufficiently analyzed therefore; this study was planned for dental age estimation on specific population. Few studies have been published on accuracy, validation and correlation of tooth staging of different methods and dental age estimation. Hence, it is important to find out the correlation between the tooth staging methods. A total of 800 orthopantomograms were collected from the original South Indian population of Haryana and New Delhi divided in age categories between 15 and 27 years. On the radiographs, the developmental stage of the third molar was scored, applying a nine scoring methods such as Gleiser and Hunt, Haavikko, Demirijian, Harris & Nortje, Moorrees et al, methods. Statistical analysis were obtained on data such as Multiple regression formulas ,Root mean squared errors for absolute error made in age prediction, R2 for correlation between age and different scoring methods, Spearman correlation coefficient for correlation contralateral third molars, probabilities to be older than 18 and 21 years is given a specific score for mandibular and/or maxillary and JK cross-validation for the expected error in the age prediction. The multiple regression models and mean absolute error were calculated. Comprising of different tooth staging methods revealed that, males are highly correlated with tooth staging as compared to females; Demirijian and Morrees et al Gleiser and Hunt methods have more statistical significant correlation than other tooth staging methods. No statistical significant difference between antimeres is found. The probability of being older than 18 years is high as compared to 21 years is established.

Key Words: Forensic odontology, Dental age estimation, Third molars, Orthopantomograms, Tooth Staging methods, South Indian population.

INTRODUCTION

In recent years age estimation has become increasingly important, in particular, in determining the age of living persons. From a legal perspective, such age estimates are carried out to determine whether a suspect without legal identification documentation has criminal liability or whether general criminal law in force for adults is to be applied in a particular case. In many countries, particularly India, the age thresholds of relevance to criminal prosecution lies between 18 and 21 years of age. According to Indian criminal law, subjects below 18 years old are exempted from criminal liability and are subjected

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to special criminal standards. In specific circumstances person under mental pressure from others to do illegal activities over 18 and 21 years of age are subjected to the criminal standards applicable to minors under 18 years of age according to the Indian Minor Law. According to marriage law, boys and girls have a right to marry at an age of 21&18 years respectively. [1]

Tooth development is uniform, changes with dental eruption and less influenced by external factors as malnutrition, disease and mental stress. Numerous odontological studies have also been carried out to establish age, assess tooth staging within acceptable error limits. [3-45] Reliability in estimating age from dental development is not uniform from birth to adulthood. After the age of 16, most of the teeth are already developed, age estimation becomes more difficult because only the developing teeth if involved are the wisdom teeth [7]. The difficulties in the study of third molar development and in its clinical or forensic applications are especially related to the variability, mostly related to population differences, other factors, such as gender, age, and degree of dental maturation of the individuals in the different samples and formation of these teeth. Recently, for different ethnic groups, numerous reports have been published on the evaluation of third molar development and further studies were indicated for specific populations [5-16] .Various radiological methods for dental age assessment based on tooth mineralization staging have been proposed [17-25]. Validity, accuracy, correlation of an age estimate, crucially depends on the classification methods used, the most appropriate and precise method should be selected. No study was evaluated and performed on comparison of nine tooth staging methods, while few studies have been published on accuracy, validation and correlation of tooth staging less than nine methods and small samples size [26,27].

Hence, the present study is aimed to add reference data based on forensic science application in age estimation from third molar formation and to find the correlation, accuracy and validation of tooth staging methods in third molars and age estimation, as well as to make a regression model for dental age estimation from South Indian population.

MATERIALS AND METHODS

Main 800 orthopantomograms of south Indian between 15 to 27 years of age were chosen. The criterias for inclusion into the main & test samples were good radiological image quality, selection of patients with an existing and valuable birth certificate and known date of X ray exposure, no history of medical disease or surgery affecting the presence and development of teeth. All of the 4147 third molars visible on the orthopantomograms were classified by nine dental tooth staging methods such as Gleiser and Hunt method (GH), [17] Haavikko (HV) [18], Demirijian (DM) [19] , Harris & Nortje (HA)[22], , Moorrees et al (MO) [24], and in case of doubt, imported into Adobe Photoshop CS3 (Adobe Systems Incorporated, San Jose CA). [17] All measurements and scorings were done by one examiner. A test data base of 100, same population was used for validation of a formed regression models.

The general statistical analysis was based on multiple regression analysis in order to obtain multiple regression formulas. At 95% confidence intervals, R2 was calculated to find out the correlation between age and different scoring methods amongst themselves. Spearmen correlation coefficient between contra-lateral third molars was calculated. Probabilities to be older than 18 and 21 years given in a specific score for lower and/or upper molars were calculated by using jack-knife cross-validation, the expected error in the age prediction was studied .All analyses have been performed using SPSS (Version 11.0)

RESULTS

The regression formulas were subdivided based on the categories such as tooth development methods, gender, the number and the location of third molars present, depending on the available

number of third molars in individual. Root mean square standard error was calculated (Table-1).

In males correlation with tooth staging of different methods was high as compared to females, although highest in DM followed by GH. Significant Spearman correlation coefficients showed a strong correlation between the different variables such as methods, sex, and position of third molars. The correlation coefficients between anti-meres did not result in a statistically multicolinearity and therefore both antimere were used in same model. The 95% probability of individual being older than 18 years and older than 21 years were highest in all fully developed thirds molars in GH and MO tooth staging methods, while in CA probability was less than 80%. Also, probability of individual being older than 18 years was high as compared to 21 years old. Further, it was much higher in females than males.

DISCUSSION

The increasing tourisms, illegal migrations, criminal activity urge the need to take into account, the ethnical background of the individual while performing dental age estimation,[13-46] therefore dental age estimation of majority in juvenile individuals should be based on data collected in the appropriate ethnical group . In current study, the database and corresponding regression models provide forensic investigators in any part of the world, with a specific scientific tool when asked to provide judicial advice concerning the age of majority of a individuals from North Indian origins. The regression equations were derived for DM and MO. In the present, evaluation multiple regression analysis of two methods led to clear formulae and its easily applicable in specific conditions (Table-1). In this study, tooth staging of MO method showed highly statistical significant correlation with age estimation followed by DM as compared to other methods and difference between MO and DM tooth staging with age were statistically insignificant (95% C I). While in previous studies , DM followed by GH methods were most valid and accurate as compared to other methods [26,27].It may be due to small sample sizes. Increasing the number of tooth formation stages might improve accuracy, but too many may reduce precision [28]. A high statistical insignificant correlation was found between age and third-molar development in females as compared to males which was contrary to the previous studies [29-31].Spearmen correlation coefficient of maxillary third molars were higher as compared to mandibular third molars in males & females , although higher in males than females.

An individual of Southern Indian origin whose tooth development was complete, was over the age of 18 years and 21 years were comparable to previous studies [33,35] . The probability being older than 18 years was high in females as compared to males in South Indian as it was in Japanese[35]but it was observed opposite in Belgisan Caucasian origin [33]. At 95% confidence intervals, no statistical significant difference was found in tooth staging of different methods among themselves.

Because of large standard deviations which are changing dental staging methods in age estimation, tooth staging regression models are combined with other methods such as skeletal maturity indicator, psychological methods of age estimation which may give good results.

CONCLUSION

In tooth staging methods, standard deviations were high in age estimation. Increasing the number of tooth staging did not give new information about age estimation. Select the tooth staging methods having distinguished tooth stages with ease of reproducibility and reliability. Finally, number of tooth staging is less important as compared to distinguished stages.

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