

Radiographic Evaluation of Third Molar Development in Relation to Chronological Age among South Indian Population

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Abstract

Background: The aim of the study was to correlate the radiologic development status of third molars with that of chronologic age specifically among individuals belonging to Dakshina Kannada and Udupi district in the age group of 16-22 years.

Method: A total of 152 orthopantomograms (OPG) were evaluated to assess the development status and scored using the evaluation method suggested by Gleiser and Hunt. Intra- and Inter-observer reliability was evaluated using the kappa statistics. Statistical tests used were multiple regression analysis and Pearson correlation coefficients.

Results and Conclusion: The formula to determine chronological age among females is $\text{Age} = 13.416 + (-0.873 \text{ Upper Right (UR)}) + 0.803 \text{ Upper left (UL)} + 0.536 \text{ Lower left (LL)} + 0.362 \text{ Lower Right (LR)}$ with standard deviation of 1.61, and for males is $\text{Age} = 12.766 (-0.187 \text{ UR}) + 0.748 \text{ UL} + 0.873 \text{ LL} + (-0.541 \text{ LR})$ with SD of 1.57.

Key Words: Third molars, Age estimation, Orthopantomogram,

Introduction

Age estimation in forensic medicine has a wide application and is a crucial area of research. Precision in forensic age estimation techniques can be challenging. It is known that the age estimation methods in living individuals need to have higher standards of accuracy compared to age estimation for the decedent.¹ There are also limited methods available for age estimation in the living. The Forensic Anthropology Society of Europe recommend three methods of analysis for age estimation which include, physical examination, radiographic

assessment of left hand and dental examination (including OPG); including radiographic assessment of the clavicle's medial epiphysis to determine if the individual is over or below 21 years of age.² Radiological analysis in forensic is extremely feasible and most economical, and thus is central to age estimation methods. Although there are variety of skeletal maturity indicators for age estimation in radiology, examination of teeth is increasingly gaining popularity in determining chronological age because of the reported low variability of dental indicators.³ Also, imaging of teeth are less expensive and involve less exposure to radiation in comparison to other radiological indicators of skeletal maturity.⁴ There is extensive research published which deal with age estimation techniques among adults and non-adults separately. Especially among non-adults the teeth are effective indicators of chronological age. However, there is limited research that study tooth related age estimation techniques among individuals in

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the transition zone of juvenile to adulthood.

Determining the chronological age of an individual in the transition period as juvenile or adult has enormous legal implications in civil/criminal cases. It is crucial in cases of child labour, child marriage inheritance disputes etc. Accurate age estimation is critical in criminal proceedings, wherein the age of a suspect without valid identification documents might have to be assessed to determine the applicability of general criminal law in force for adults or criminal law for juveniles. Increase in incidence of migration and asylum seekers have elevated the importance of determining the age of the undocumented.^{1,3} In India the legally relevant age limit for reaching adult status is 18 years.

Third molars are among the few indicators in forensic radiology that can be used to differentiate the age of an individual in the transition zone from juvenile to adult. Generally, all permanent teeth would have completed development around 18 years of age, except for the third molars. Thus, during these transition years, i.e from 16 to 22 years the third molars are the only developing teeth that are viable for age estimation.^{3,5,6} The higher incidence of congenital abscess of third molar and its variability in morphology and eruption pattern has led to questions regarding its significance as developmental marker has been questioned. Nevertheless, third molar development is an option to be explored as an age estimation indicator for medicolegal purposes, particularly in absence of other biological indicators during the transition phase between adolescence and adulthood.^{7,8}

Ethnicity, genetics and various environmental factors affect tooth development. The variations in tooth development based on these factors have been well documented. Therefore, availability of a population specific reference data set for tooth developmental is essential for forensic age estimation of living people.^{3,9,10} Thus, this observational study was carried out to correlate the radiologic development status of third molars with that of chronologic age specifically among individuals belonging to Dakshina Kannada and Udupi district in the age group of 16-22 years.

Material and Methods

A prospective study was carried out in which the patients above the age 16 years and below the age of 23

years, visiting the radiology section of the department for an OPG were included. The digital radiographs were taken generated on a Kodak (Gendex, IL, USA). They were stored as JPEG files. The exact date of birth of the subjects and the date on which the OPG was taken were noted. A written informed consent was taken from the patients included in the study.

Inclusion criteria

1. Patients between the age groups of above 16 years and below 23 years
2. Patients in whom OPG is indicated for diagnosis of condition for which they have visited the institution
3. Patients who were resident of Dakshina Kannada or Udupi district
4. Presence of atleast one third molar as evaluated in the OPG

Exclusion Criteria

1. Patients with systemic disease that could affect development of dentition
2. Dental pathology related to third molars
3. History of trauma to jaw bones
4. Panoramic radiographs in which the visualization of the third molars is have errors obscured due to error or improper inclination of the molar

A total of 200 OPGs were assembled for evaluation. The chronological age of the patient on the day the OPG was taken was calculated using an online age calculator available at <http://www.calculator.net/>.

The OPGs were evaluated by two trained observers. The observer was blinded to the chronological age of the subjects included in the study.

Developmental status of the third molar was determined based on its radiographic appearance and a score was allocated to each tooth based on the method framed by Kohler et al¹¹, which is a modification of the method given by Gleiser and Hunt.¹² This method of scoring divides the development of teeth into 10 stages and a score is given corresponding to a particular stage of tooth development. The least score was noted in case

the tooth had multiple roots. The scoring was carried out by two specialized observers and inter-observer reliability was calculated. Also, at the beginning of the study, the observers repeated measurements of 20 OPGs with an interval of 2 months in order to evaluate intra-observer reliability.

Statistical analysis: All the analysis was done using SPSS 19 version. Pearson correlation coefficient was calculated to evaluate the correlations among the 4 molar stages. Multiple Linear regression was used to calculate the regression equation to predict the actual age from the 3rd molar eruption stage. Different combinations of equations were generated separately for males and females.

Results

A total of 200 OPGs were included in the study. Among these OPGs a total of 152 OPGs had all four third molars. The rest had atleast one molar missing. As there was insufficient sample size to calculate a multiple regression formula for groups with one or more missing molars they were excluded from the study. Thus only 152 OPGs which had all four third molars were included to get the results. Out of the 152 OPGs 84 belonged to females and 68 belonged to males.

The k statistics for inter and intraobserver reliability was 0.74 and 0.78 respectively. For males, statistical analysis revealed a high Pearson correlation coefficient of 0.93 between the developmental stage of Upper right molar (UR) and upper left molar(UL) and a similar correlation coefficient of 0.98 was found between Lower right molar (LR) and Lower left molar (LL). For females, correlation coefficients of 0.93 and 0.95, respectively, were found. High correlation coefficients of 0.9 were found between upper and lower third molar combinations both for males and females (Table 1).None of the individuals in both male and female group younger than 18 years were given score of 10 i.e none of the individuals younger than 18 years showed complete root formation. The formulas derived from multiple regression analysis for all third molar scores for females is $Age = 13.416 + (-0.873 UR) + 0.803 UL + 0.536 LL + 0.362 LR$ with standard deviation of 1.61 and for males it was found to be $Age = 12.766 (-0.187 UR) + 0.748 UL + 0.873 LL + (-0.541 LR)$ with a standard deviation of 1.57.

Discussion:

Accurate age estimation in living has considerable significance from the ethical, legal and criminal perspective. Verification becomes essential when credible proof of chronological age is unavailable. Accurate age estimation depends on calculations derived from reference studies that have included population with similar genetic–geographic origin and the concomitant socio-economic status. Apart from scientifically sound research, accurate age estimation also required contemporarily prescribed legal requirements.^{9,10}

Age estimation methods have been traditionally studied in two categories of adults and non-adults. However, the transition zone between adults and non-adults has not been sufficiently explored. This is surprising since determination of chronological age of an individual in the transition zone from juvenile to adult has varied legal implications, with far reaching consequences in consideration to criminal law.^{3,4,9} In India the legally relevant age limit for reaching adult status is 18 years and considering the chronology of tooth development third molars are the only permanent tooth that can be assessed for dental age estimation.^{3,5,6}

Various studies have utilized third molars for predicting chronological age. In these studies, the most common method used to assess the third molars have been Demirjian's method or Kohler et al¹¹ modification of the method of Gleiser and Hunt.¹² The modified method of Gleiser and Hunt that has been followed in the present study has been utilized by Mesotten et al.³, K. Gunst¹³ and M. Van Vlierberghe et al.¹⁰ However, methodology to obtain the formula for predicting the chronological has been different in the above mentioned studies. M. Van Vlierberghe et al¹⁰ applied single quadratic and support vector regression whereas Mesotten et al³, K. Gunst¹³ Thevissen et al¹⁴ and Lee et al¹⁵ have utilized a multiple regression analysis. Analysis through Bayesian approach was considered in a separate study in which the authors concluded that there was no drastic advantage of this method in comparison to traditional regression analysis. Recently, Arge et al¹⁶ have utilized transitional analysis for third molar development assessment. This method may not accurately predict the age of an individual, however it is a good indicator of the probability of the age at a given tooth development status. In the present

study, the methodology followed was according to Mesotten et al.³

In the above mentioned studies it was found that the completion of third molar formation occurred earlier in males than females. No such comparisons could be made in the present study as there was variability in the number of subjects in the male and female group. In the study by Mesotten et al¹ and Grunt et al,¹³ it was found some individuals below the age of 18 years showed full molar development, which enabled them to calculate the probability for an individual to be older than 18 years in case of full third molar development. However, in the present study none of the individuals below 18 years of age showed complete root formation. In fact, among the individuals above 18 years only 5.2% of the upper molars and 6.3% of the lower molars showed completion of third molar development. This clearly indicated that there is a lag in the development of third molars in the South Indian population from Dakshina Kannada and Udupi district in comparison to the

Caucasian population from Belgium. Also, completion of the third molar development can be a good indicator in the population group of the present study to predict the chronological age of being above 18 years, i. e of being above the legal age limit. Previous findings have also shown that the mineralization of the wisdom teeth is a population specific process and does not occur in every ethnic group at the same age.⁵

In the study by Mesotten et al³ which was later furthered by Grunt et al,¹³ formulae were obtained not only when all third molars were present, but also for situations with one or more missing molars. In the present study due to the small sample size, formulae could not be derived in case of one or more missing molars. The main advantage of this study is the selection of radiographs of individuals in a narrow age range. This will help to get a more accurate predication of age owing to narrow mean age. The main limitation of this study is the small sample size, due to which formulae could not be derived in case of one or more missing third molar.

Table 1: Pearson correlation coefficients between upper and lower third molars for males and females

Sex		UR	UL	LL	LR
Females (n=84)	UR	1	.993**	.939**	.940**
	UL	.993**	1	.940**	.944**
	LL	.939**	.940**	1	.995**
	LR	.940**	.944**	.995**	1
Males	UR	1	.993**	.933**	.937**
	UL	.993**	1	.941**	.939**
	LL	.933**	.941**	1	.988**
	LR	.937**	.939**	.988**	1

Conclusion

The study revealed that chronological age can be determined using developmental stages of all four third molars with standard deviation of 1.61 among females and, 1.57 for males. Despite certain limitations, third molars can be used to determine the chronological age of individual in the transition period from juvenile to adulthood.

Conflict of Interest: There are no conflicts of interest in this research work

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Ethical Clearance: Institutional Ethical Committee Clearance was obtained prior to conducting the study

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