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Evaluating the reliability of two dental age estimating methods in younger individuals of Malaysian population - A radiographic study

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Abstract

Age estimation presents a complex problem and requires considerable experience in recognizing significant changes and allowing for their variability with in any particular population. Tooth eruption and tooth calcification are the two events that can be used to measure dental age in children and adolescents. Although, Demirjian's and Nolla's method are considered standard for dental age estimation, it may not be reliable for all population.

Aim: The goal of the study was to evaluate the reliability of Demirjian's and Nolla's method of dental age estimation in determining chronological ages in younger individuals of Malaysian population based on developmental stages of third molar.

Study Design: A retrospective study was performed on panoramic radiographs of 100 subjects aged between14 to 22 years. Estimated age (EA) was calculated using Demirjian's and Nolla's methods and compared with chronologic age (CA) for each patient.

Results: The mean of CA of the study sample was 18.5500 ± 2.36. Using the Demirjian method, the mean of EA was 18.8562 ± 2.10. For Nolla method, the mean of EA was 17.1625 ±2.11.

Conclusion: Hence the above results indicates that the Estimated age (EA) by Demirjian method was more close to chronologic age (CA) showing no significant variations between the two, Suggesting that the Demirjian method is more significant in determining age in younger individuals of Malaysian population.

Keywords: Third molar, Chronologic age (CA), Estimated age (EA), Demirjian's method (D), Nolla's method (N).

Introduction

In the recent years the number of unidentified cadavers and the number of human remains lacking age documentation has increased. This necessitates age calculation, not only for differentiating the juvenile from the adult status in criminal law cases, but determining the age of a crime victim and also for estimating chronologic age in relation to school attendance, social benefits, employment, and marriage. Identification of individuals in such disasters is carried out by multidisciplinary approach and Dentists assist the other disciplinarians involved in crime investigation by identifying the criminals, as well as victims of crime and disaster, through dental records.(1,2)

Although several parts of the body can be used for age estimation, but the teeth are that part of the body frequently used for identification and age estimation when skeletal remains are in poor condition, they have been used from as early as 19th century.(3,4) Saunders, a dentist, was the first one to publish information concerning dental implications in age assessment by presenting a pamphlet entitled "Teeth a Test of Age" to English parliament in 1837.(5,6)

One of the earliest methods of age estimation developed by Gustafson was based on histological examination of ground thin sections of teeth. The application of radiology in forensic sciences was introduced in 1896.(7,8)

Among all, the third molars offer a unique advantage over other teeth. Approximating the age becomes complex after about 14 years since all the permanent teeth, except the third molars would have completed their development, which leads to be the only clue used for age estimation. Besides that, compared to bone development, third molar development is less affected by variations in endocrine and nutritional status. The third molar development continues until the early twenties when the development of almost all permanent teeth may be completed, plus the regressive changes in teeth with increasing age may not appear at that age.(9)

Several methods(9,10,11,12) have been used to determine the DA according to the degree of the calcification observed in radiographic examinations in permanent teeth.

Forensic dentistry is a relatively new field in Malaysia and so it has remained unexplored and unexposed to many member of the healthcare workforce. The minimal amount of studies done in this field led to lack of knowledge and awareness of the vast possibilities and benefits forensic dentistry can offer us. Based on above context, we picked up of study on accuracy age estimation using radiographs. Our study is a retrospective study involving the orthopantomograms (OPG's) which are already taken during the treatment in AIMST Dental Institute. The aim of this research was to compare the accuracy of Demirjian's and Nolla's dental age estimation methods based on radiographic evaluation of third molar developments in Malaysian population and create awareness among young dental students on the prospects of forensic dentistry.

Materials and Method

The present research is a radiographic retrospective study which comprised of 100 OPG's taken at the Faculty of Dentistry, AIMST University, Bedong, Kedah, Malaysia, in the period from 2008 to 2015. 100 subjects were considered in our research with known chronologic age among which 50 were females and 50 males, aged between 14 to 22 years. We set the age limit of 14 years for an accurate radiological evidence of third molar even though Gravely (7) found the peak formation period at the age of nine years.

Inclusion criteria

- Age groups between 14-22years
- The entire sample was Malaysian origin
- High quality OPG's
- Third molars devoid of any developmental anomalies, dental caries, restoration, root canal treated, hypercementosis and fractured tooth

Exclusion criteria

- OPG's showing partially edentulous arches
- Any abnormality involving third molar were excluded
- OPG's with missing third molars

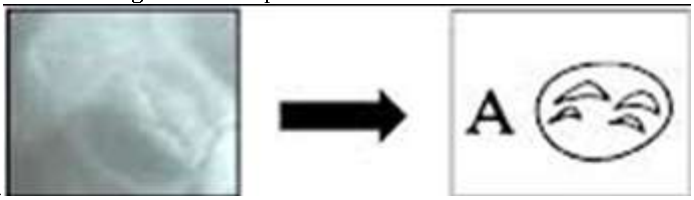
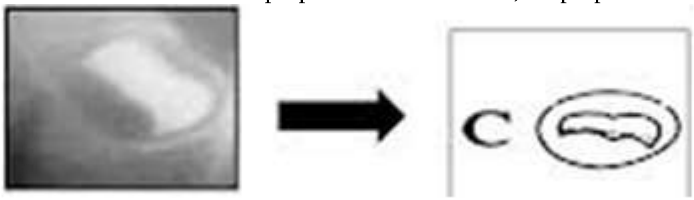
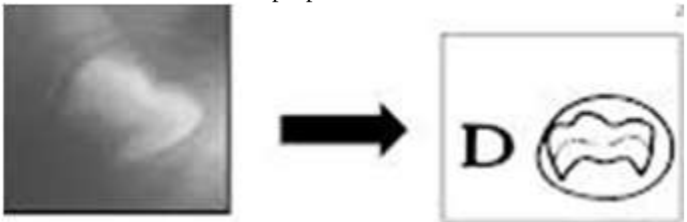
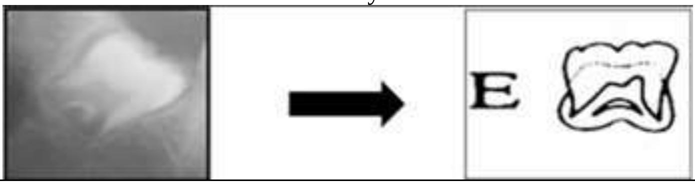
The study included a Data Collection form, where in all the four third molar details and also the sociodemographic details, with the patient's name, sex and date of birth.

The OPGs were collected from AIMST Dental Institute. All orthopantomograms were taken with the same device from the subjects attending to the Faculty of Dentistry, AIMST UNIVERSITY and evaluated using X-ray viewer under good illumination. The OPGs obtained were coded in order to avoid bias during scoring of the radiographs. The investigator did not know the chronologic age of the subjects when assessing the radiographs. The radiographs were examined separately by two observers whereby one noted down the developmental score for all four third molars using formation stages described by Nolla[8] (Table 1). Then the other observer noted the different stages of development of third molars based on method adapted by Demirjian[9] (Table 2), which includes stages A-H. The mean of all the estimated age for all four third molars in a particular individual was calculated. In order to avoid the examiner bias at the time of collecting data, CA was first determined by subtracting the date of birth from the date of OPG on a data collection sheet and the EA scores were tabulated later on a separate sheet.

Table 1: Nolla's Developmental Score

Nolla's developmental score	Description	Estimated age
0	Absence of crypt; no sign of tooth development is apparent.	-
1	Presence of crypt; crypt is formed but no mineralization has begun.	9.9
2	Initial calcification; amelogenesis has begun on the cusp tips.	10.4
3	One-third of crown completed.	11
4	Two-thirds of crown completed.	11.5
5	Crown almost completed; morphologically, the crown has mineralized to just short of the cervical margin.	12
6	Crown completed, but root formation has not yet begun.	12.6
7	One-third of root completed.	15.2
8	Two-thirds of root completed.	16.9
9	Root almost completed; full root length has been achieved, but the apex is still opened.	17.7
10	Root completed; apical end of root completed and apex is closed.	19.5

Table 2: Demirjian stages of age estimation

Stage	Radiographic appearance	Mean age in years according to stage	
		Male	**Female**
A	Calcification of single occlusal points without fusion of different calcifications. 	9.63	9.46
B	Fusion of mineralization points: the contour of the occlusal surface is recognizable 	10.65	11.02
C	Enamel formation has been completed at the occlusal surface, and dentine formation has commenced.the pulp chamber is curved, no pulp horns visible. 	13.05	11.96
D	Enamel formation has been completed to the level of amelocemental junction. Root formation has commenced. The pulp horns are beginning to differentiate, but the walls of pulp chamber remain curved. 	14.63	14.91
E	The root length remains shorter than the crown height. The walls of pulp chamber are straight, and the pulp horns have become more differentiated than in the previous stage. In molars the radicular bifurcation has commenced to calcify. 	17.11	17.33
F	The walls of pulp chamber now form an isosceles triangle, and the root length is equal to or greater than the crown height. In molars the bifurcation has developed sufficiently to give the roots a distinct form. 	18.15	19.33

G	The walls of root canal are now parallel, but the apical end is partially open. In molars, only the distal root is separated.  	19.60	20.22
H	The root apex is completely closed (distal root in molars). The periodontal membrane surrounding the root and apex is uniform in width throughout.  	20.86	21.60

Estimated Age (Demirjian method): The development of each third molar i.e. 18, 28, 38 and48 was recorded based on an 8-stage scale from A to H, the mean age of all the four teeth (18, 28, 38 and 48) was considered as EA for that particular subject.

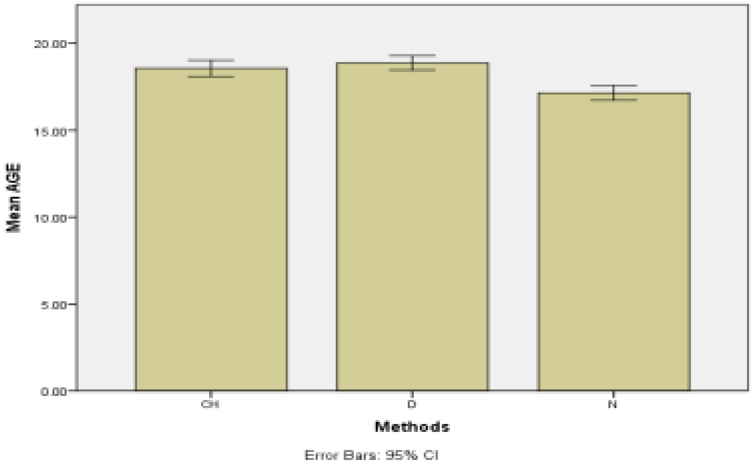
Estimated Age (Nolla method): Each third molar i.e. 18, 28, 38 and 48 was assigned a stage given by Nolla's, (which includes 10 stages for different stage of development of tooth) and the age was recorded. Then the mean age of all the four teeth (18, 28, 38 and 48) was considered as EA for that particular subject.

Descriptive analysis, one way analysis of variance (ANOVA) was used to analyze the predicted age by Demirjian and Nolla's method with that of chronological age, followed by Duncan's multiple range test to check the significance of above two methods.

Results

Mean of chronological age (CA) and for the estimated ages recorded by Demirjian(D) and Nolla's (N) methods were calculated (Graph 1), which was 18.5500 ± 2.36 for CA, 18.8562 ± 2.10 using D method, which is slightly overestimated but nearing to CA and was 17.1625 ±2.11 using N method. This indicates that the estimated age (EA) by Demirjian method was more close to CA showing no significant variations between the two (Graph 1).

Graph 1: Mean calculation of CA, D and N method



CA: chronological age
D: Demirjian method
N: Nolla's method

One way analysis of variance (ANOVA) was used to analyze the estimated age by Demirjian(D) and Nolla's(N) methods in comparison to CA, which was followed by duncan's multiple range test (Table 4) to check the significance of the two methods. This suggested that there was not much significance variation between Demirjian(D) method and CA. Suggesting that the Demirjian method is more significant in determining age in younger individuals of Malaysian population.

Table 3: Descriptive analysis

Descriptives								
AGE								
	No. of sample	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
CH	100	18.5500	2.36718	.23672	18.0803	19.0197	14.00	22.00
D	100	18.8562	2.10148	.21015	18.4392	19.2732	13.44	21.60
N	100	17.1625	2.11109	.21111	16.7436	17.5814	12.30	19.50
Total	300	18.1896	2.31043	.13339	17.9271	18.4521	12.30	22.00

Table 4: Duncan's multiple range test

Age			
Duncan[a]			
Methods	N	Subset for alpha = 0.05	
		1	2
N	100	17.1625	
CH	100		18.5500
D	100		18.8562
Sig.		1.000	.325

Discussion

Age estimation based on tooth development has two significant influences - genetic variability and environmental factors. Till date, others have strived to minimize variability in outcomes by defining genetically similar population sub-sets to provide standard tables that are specific to these genetically similar individuals, therefore reducing the effect of one of the two influences on tooth development.(10) Hence developing third molars were used in our study.

Developing teeth are used most reliably in age estimation as teeth are the most indestructible part of the body and exhibit the least turnover of natural structure. There they can survive death and remain relatively unchanged after many years. That is why the anticipated developmental sequence that human dentition follows, can be utilized in age determination. Various methods have been devised ranging from dividing tooth development into 22 stages (Schour & Massler 1941) to 3 stages (Garn et al. 1959).(13)

There have been several different methods to determine DA. Among all methods used to assess DA, the methods of Demirjian et al.(14) and Nolla are commonly used in teaching and clinical practice,(15,16) hence these two methods were the obvious methods for the present study. Demirjian *et al.* classified the development of teeth into 8 stages and arrived at an age estimation method. One of the commonest changes carried out in Demirjian method was the replacement of centile maturity curves with regression formulas and the incorporation of the third molar to expand the scope and duration of age prediction using this method.(17)

In Present study Demirjian method showed an overestimation of mean age of about 0.3 in comparision with the mean of chronological age, which is similar to results from other studies that used the Demirjian method and showed an average overestimation in dental age ranging from 0.02 to 3.04 years.(18,19,20) This wide range might be due to the ethnic differences, climate, nutrition, socio-economic level, urbanization age structure of the study samples, sample size, statistical methods.(15,21)

Our study shows an underestimation of age by Nolla's method in comparsion with CA, with a mean difference of 1.39, which is similar to other studies where there was underestimation of age using Nolla's method with different values.(15,22)

From the data obtained, of all the age group, Demirjian method was more favorable, with a mean ± SD being 18.8562 ± 2.10, which was nearly close to the mean of chronological age of 18.5500 ± 2.36. Overall, we found that Demirjian method tended to overestimate chronological age and the Nolla's method tended to underestimate it, although the differences were less in relation to real age.

Conclusion

Based on the results of this study, Demirjian method is more accurate in determining age in younger individuals of Malaysian population compared to Nolla's method. There was a not much significant variation between D method and CA; hence D method can be used to estimate age in Malaysian population.

In overview, the developmental stages of the third molar can be the only quantitative biologic variable available for the estimating the age of a person in his/her late teens or early 20s but in, *in-vivo* cases this non extraction method of age estimation would be the most sought out method while determining the age in case of medico-legal issues, and this method may prove to be useful.

Thus we conclude that examination of the developmental stage of third molars using orthopantomograms can be a useful tool for chronological age determination in the field of legal and forensic medicine. However, third molar growth and calcification is definitely not the most reliable development marker. Nevertheless, it is a favorable indicator during the late teens and early twenties. The reliability of using this to distinguish juvenile versus adult individuals is questionable.

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