Forensic age estimation using foti's method– A radiographic study

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Abstract

Introduction: Foti et al. proposed four mathematical models to determine the age by counting the erupted teeth and germs in children, obtained with the help of stepwise ascending multiple linear regressions. Among the four models, Model 1 regressive formula helps to determine the age by using radiographs that shows teeth and dental germs. The present study was conducted to evaluate the efficacy of Foti's method of dental age estimation by comparing the age estimated with the chronological age in the study population.

Materials and Method: A retrospective study has been conducted using 62 panoramic radiographs of subjects ranging from the age 6-20 years. The age estimation is done by Foti's Model No. 1 regressive equation using radiographs showing erupted teeth and dental germs.

Results: Statistical analysis indicated that there is significant difference between chronological age and age obtained by Foti's method (p-value <0.01). There was a mean difference of 5.07±2.5 which suggests that there is overestimation of age when Foti's model 1 regression formula is used in the present study population.

Conclusion: The present study indicates that Foti's Model 1 regression formula is inappropriate for age estimation in the present study population.

Keywords: Age estimation, dental age, Chronological age, Forensic dentistry, Foti's method.

Introduction

Forensic age estimation is the determination of age of an unknown individual as per the request of courts or other government authorities.[1] Estimation of age in living individual is performed for criminal investigations, civil purposes and in immigration procedures. In addition, the age estimation of an unknown dead helps in searching for ante-mortem data by narrowing down the age interval. Different methods like anthropometric measurements, skeletal maturation and dental maturity have been used to estimate the age.[2] Age estimation by using teeth have become one of the accepted method as the formation of teeth, time of eruption and shedding is almost constant in every individuals.[3] Various morphologic, histologic, biochemical and radiographic methods have been used to determine the dental age and to evaluate the age dependent changes in the teeth.[4] Radiographic method is simple, non-invasive and reproducible and can be employed on both living and unknown dead.[5]

The radiographs are used for age estimation by assessing the different stages of mineralisation, degree of formation of crown and root structures, the eruption sequence and the mixed primary and permanent dentitions.[6] Formation of teeth and its eruption sequence are widely used as a growth marker in forensic dentistry and anthropology to assess the maturity and to estimate the age. Several methods have been proposed by different authors to estimate the age based on tooth eruption and most of the techniques are not easy to use and practical. Foti et al proposed four simple mathematical models to determine the age by counting the erupted teeth and germs in young individuals, which is applicable both in clinical and radiographic examination. Among the four models, Model no.1 permits the determination of age of a person from the radiographs showing teeth and dental germs.[7] Hence the present study was conducted to find the accuracy of Foti's method for age assessment in young individuals of Mangalore population.

Materials and Method

A retrospective study was conducted in the Department of Oral Medicine & Radiology, Yenepoya Dental College & hospital, Yenepoya University, Mangalore. After obtaining Ethical clearance, 62 panoramic radiographs of patients with the age group of 6 to 20 years that have been taken for various diagnostic purposes are collected from the archives. Radiographic images were retrieved using Agfa NX software and displayed on the computer screen. Radiographs of individuals with developmental anomalies like hypodontia and hyperdontia, any diseases affecting the bone and faulty radiographs were excluded.

After obtaining the chronological age by subtracting the Date of Birth from the Date of Radiograph taken, the dental age is calculated by using the following Foti's Model 1 regression equation.

Age= 16.088 - (0.226 x No. of erupted permanent upper first molars) + (1.564*No. of erupted permanent upper second molar) + (0.832 x No. of upper erupted third molars) + (0.912 x No. of lower erupted third molars) - (1.699 x No. of germs on radiographs, except third molar tooth germs)

To define the criteria of tooth eruption from radiographic point, a line overlying the erupting tooth

cusps have to reach the mesial and distal cementoenamel junctions of the erupted adjacent teeth (Fig.1). And the germs are considered to be present at the stage of crown calcification based on Demirjian's stage A (Cusp tips are calcified but have not yet fused – Fig. 2).

A paired sample t test was conducted to compare the chronological age and the age obtained by using Foti's method.

Observation and Results

The mean chronological age of the sample population is 13.733 and the mean estimated age is 18.80. The paired t test had shown significant difference (p-value <0.01) between the chronological age and the age estimated using Foti's method (Table 1). There was a mean difference of 5.07±2.5 which suggests that there is overestimation of age when Foti's model 1 regression formula is used in the present study population (Table 2).

Discussion

In recent years the determination of age has become important in living individuals for criminal investigations. Estimation of age of an unknown individual can be performed by correlating the physical, skeletal and dental maturity. Among the entire growth systems the dental maturity has the highest stability and hence it provides the most accurate way of assessing growth and development. Evidences say that dental development is less affected than skeletal development by malnutrition and hormonal disorders.[8] Hence the age of an unknown young individual can be reliably determined from the dentition and its eruption sequence.

The present study was conducted using the Foti's Model 1 regression formula which helps in determining the age of an individual from radiographs showing teeth and dental germs. The study showed overestimation of age of more than 6 years in all the patients in the age group of

6 to 10 years, 92 % of the patients among the age group of 10 to 16 years showed an overestimation of more than 4 years and 61% among the age group of 16 to 20 years showed overestimation of more than 2 years. Underestimation of the age of one year was noted for one patient in the age group of 16 to 20. Statistically significant difference (p value= <0.01) was seen when the chronological age was compared with the age estimated using Foti's model 1 regression equation. This study was in accordance with the studies conducted by M.M khorate et al and Ballal et al.

M.M Khorate et al., conducted a comparative study on Goan population and they used Modified Demirjian's method, Acharya AB formula, Dr. Ajith D. Dinkar regression equation and Foti and co-worker's regressive formulas and have yielded significant difference between the chronological age and the age estimated by using Foti's Model 1 regression equation. Whereas the estimated age using Foti's model 2 regression formula which is a clinical study didn't show significant difference between the chronological age and the estimated age[9]. Ballal et al have conducted a pilot study on 25 patients in Mangalore population by using Foti's Model 1 regressive formula between the age group of 6 to 20 years. Their study concluded that there was an overestimation of age and showed statistically significant difference between the estimated age and the chronological age.[10]

In a study conducted by Javadinejad et al, to compare the accuracy of Foti's four Models of age estimation with Demirjian's method in 150 panoramic radiographs of 90 girls and 60 boys between the ages of 6 to 20 years, they concluded that a positive association was seen between the chronological age and the estimated age derived from Foti's four regressive models.[11] However, the present study conducted using Foti's Model 1 regression equation showed overestimation of the age when compared with chronological age.

Table 1: Paired samples statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Chronological age	13.733	62	4.3207	.5487
	Estimated age	18.806	62	2.4875	.3159

Significant difference was seen between the chronological age (M=13.733, SD=4.3207) and the age estimated by using Foti's method (M=18.806, SD=2.487); t (61) = -16.000, p = <0.01.

Table 2: Paired samples test

		Paired Differences					t	df	Sig. (2-tailed) p-value
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Chronological age - Estimated age	-5.0737	2.4969	.3171	-5.7078	-4.4396	-16.000	61	<0.01

There was a mean difference of 5.07±2.5 which shows that there is overestimation of age when Foti's

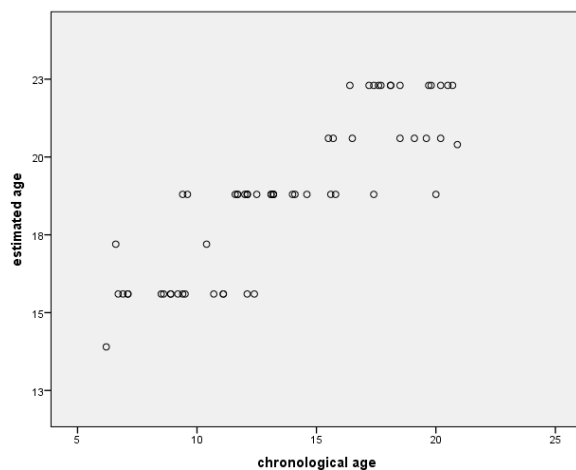model 1 regression formula is used in the present study population.

Fig. 1: Scatter plot for estimated age versus chronological age

Fig. 2: Tooth eruption criteria; a line overlying the erupting tooth cusps have to reach the mesial and distal cementoenamel junctions of the adjacent erupted teeth
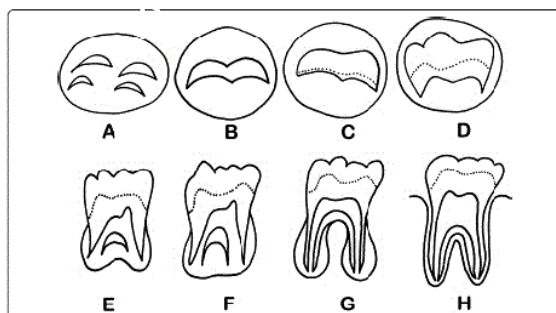

Fig. 3: Tooth germ; Demirjian's stage A (Cusp tips are calcified but have not yet fused)

Conclusion

The present study was conducted to determine the age of young individuals of mangalore population by using Foti's model 1 regression equation. The study showed over estimation of the age and statistically significant difference was seen between the estimated age and the chronological age which suggests that the present study is inappropriate for the Mangalore population.

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