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Age Estimation with Third Molars using Orthopantomograph (OPG): An Indian Scenario

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Abstract

Estimating the age of an individual is important to differentiate between adolescence and adulthood, because criminal laws are different for them. From dentist point of view, third molar is the only teeth which can differentiate these two age groups. Among the numerous methods of age estimation using third molars, assessment of mineralization and eruption status is the most commonly used method. *Aim:* To compare three radiographic methods of age estimation using the developmental stages of third molar. *Material and Methods:* 204 orthopantomographs were retrieved of known age and gender. Evaluation of the developmental stages of third molar was done by three different methods (Olze et al, Gleiser and Hunt and Demirjian et al). *Statistical Analysis*: Predictive equations were derived using linear regression analysis. The thus obtained R square values were then compared to assess the best predictive equation. *Results:* Estimation of age showed better association with respect to mandibular molars than maxillary molars. Gleiser and Hunt method was more accurate than Olze et al and Demirjian et al techniques. *Conclusion:* The better accuracy of Gleiser and Hunt method could be attributed to the greater subdivision (n=10) of developmental stages as compared to Olze (n=4) and Demirjian (n=8).

Keywords: Age Estimation; Third Molar; Mineralization; Eruption.

Introduction

The accurate age estimation of deceased may be vital for their identification. Physicians, anthropologists and dentists have devised techniques and parameters to help estimate the age using various variables which complement the absolute age. Chronological age can be equated to morphological, skeletal, sexual, psychological or dental age[1-3]. Different parameters are used to estimate age and these may either be separately used or used in combination with different degrees of accuracy.

Age estimation by assessing the dental development is considered more accurate as they are less affected by malnutrition and hormonal factors as compared to prediction by skeletal parameters[1-3]. Histology of tooth, stage of tooth eruption and tooth mineralization are commonly used to determine the age. Assessment of eruption is quick and non-invasive, but this method has disadvantage of wide variation in range for eruption of primary and permanent teeth.

Another widely used method for age estimation using teeth is by its stage of mineralization. Based on the mineralization, calcifying tooth is divided into different stages using dental radiographs. Various methods have been developed with different stages ranging from 3 to 10[4,5]. Fewer the stages, lesser will be inter-examiner variability. But accuracy of age estimation will increase with the presence of more stages.

Third molars, being the only tooth which mineralize and erupt between 16 to 22 years, may be a significant parameter in identifying the individual of adolescence to young adult [6,7]. As criminal laws are different for juvenile and adult, it is imperative to differentiate child and an adult especially, when documentation is not properly maintained [8].

The present study aims at comparing the accuracy of three radiographic methods (Olze et al, Gleiser and

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Hunt and Demirjian et al) of age estimation using the developmental stages of third molar.

Materials and Methods

Panoramic radiographs of 204 individuals of known age and gender were evaluated in the present study. There were 115 females and 89 males in this study with age ranged from 11 to 45 years. The criteria for inclusion were the availability of orthopantomograph of adequate quality in their clinical records. Patients with any medical history that could affect the presence and development of permanent teeth are excluded from the study. At the time of radiographic examination, the chronological age of each person was calculated on the basis of the reported date of birth.

The developmental stage of each third molar of a radiograph was evaluated using three techniques. In the first method, eruption stages were evaluated using the classification of stages by Olze et al. Eruption stages were classified into 4 stages [9].

1. Stage A: Occlusal plane covered with alveolar bone.
2. Stage B: Alveolar eruption; complete resorption of alveolar bone over occlusal plane.
3. Stage C: Gingival emergence; penetration of gingiva by at least one dental cusp.
4. Stage D: Complete emergence in occlusal plane.

Impacted teeth and rotated were eliminated from the analysis. (Figure 1)

In the second method proposed by Gleiser and Hunt (modified by Kohler et al) the third molar development was subdivided into 10 developmental stages. All the third molars were scored in accordance with the formation of crown and root. In the case of different developmental stage of the multiple roots of a third molar, the least developed root was evaluated and scored [10]. (Figure 2)

Third method used was the modified classification of Demirjian et al for third molars which subdivided the development into 8 stages [11]. (Figure 3)

Statistical Analysis and Results

Statistical analysis was performed using Simple Linear Regression using SPSS version 20. Regression equations were derived for each technique separately (Table 1). Overall, the age estimation using the developmental stages of the mandibular molars showed higher R square values (0.542 to 0.571) than the maxillary molars (0.475 to .526). Individually in both maxillary and mandibular teeth, Olze's technique showed the highest R and R square values of .571 in 38 and .542 in 18. Analysis of covariance (ANCOVA) showed that gender had no confounding effect on age in the stage of development (Table 2). The assessment of age by Gleiser and Hunt and Olze technique were comparable and markedly better than the Demirjian's technique.

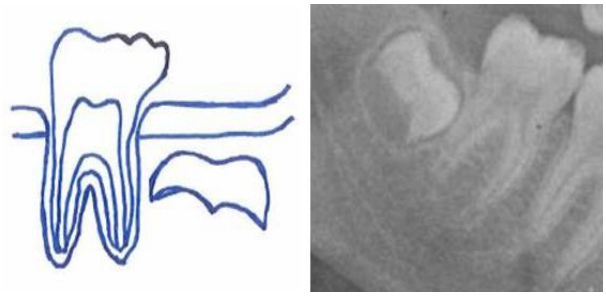
Table 1: Linear regression analysis (r square) and formula for each tooth by three methods of age estimation

S.no	Method	Tooth	R	R square	Formula
1	Demirjian	18	.709	.502	7.752+1.726(variable of 18)
		28	.689	.475	7.124+1.848(variable of 28)
		38	.742	.551	6.603+1.890(variable of 38)
		48	.736	.542	6.483+1.914(variable of 48)
2	Gleiser and hunt	18	.719	.517	10.296+1.134(variable of 18)
		28	.694	.482	10.124+1.175(variable of 28)
		38	.749	.561	9.524+1.227(variable of 38)
		48	.743	.552	9.418+1.243(variable of 48)
3	Olze	18	.725	.526	10.478+2.871(variable of 18)
		28	.710	.504	10.153+3.044(variable of 28)
		38	.756	.571	10.217+2.873(variable of 38)
		48	.743	.553	9.949+3.012(variable of 48)

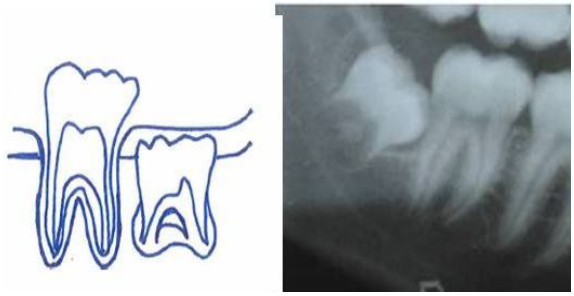
Table 2: Analysis of covariance (ancova) to evaluate the covariance of the gender over age for each tooth in each system

Dependent Variable	Source	Type III Sum of Squares	Mean Square	F	Sig.	R square
Demirjian 18	Age	333.133	333.133	173.69	**<0.001**	a. R Squared = .507
	GEN	3.382	3.382	1.763	0.186	(Adjusted R Squared = .501)
Demirjian 28	Age	314.191	314.191	156.144	**<0.001**	a. R Squared = .479
	GEN	2.669	2.669	1.326	0.251	(Adjusted R Squared = .473)
Demirjian 38	Age	372.516	372.516	223.025	**<0.001**	a. R Squared = .555
	GEN	2.32	2.32	1.389	0.24	(Adjusted R Squared = .550)

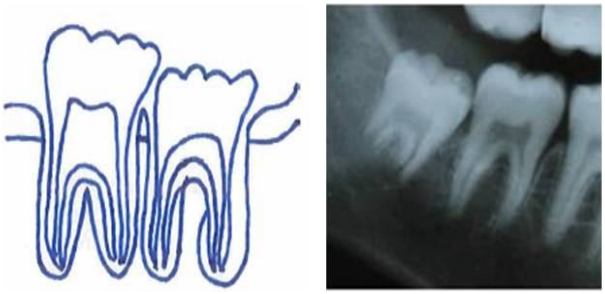
Demirjian 48	Age	359.369	359.369	216.8	**<0.001**	R Squared = .544 (Adjusted
	GEN	1.323	1.323	0.798	0.373	R Squared = .539)
Gleiser and hunt 18	Age	821.847	821.847	184.62	**<0.001**	a. R Squared = .520
	GEN	5.372	5.372	1.207	0.273	(Adjusted R Squared = .515)
Gleiser and hunt 28	Age	803.462	803.462	160.771	**<0.001**	a. R Squared = .484
	GEN	4.362	4.362	0.873	0.351	(Adjusted R Squared = .478)
Gleiser and hunt 38	Age	918.142	918.142	232.184	**<0.001**	a. R Squared = .563
	GEN	4.129	4.129	1.044	0.308	(Adjusted R Squared = .559)
Gleiser and hunt 48	Age	886.74	886.74	226.216	**<0.001**	a. R Squared = .553
	GEN	1.888	1.888	0.482	0.489	(Adjusted R Squared = .548)
OLZE 18	Age	132.428	132.428	186.678	**<0.001**	a. R Squared = .528
	GEN	0.649	0.649	0.915	0.34	(Adjusted R Squared = .523)
OLZE 28	Age	131.524	131.524	170.802	**<0.001**	a. R Squared = .504
	GEN	0.06	0.06	0.077	0.781	(Adjusted R Squared = .498)
OLZE 38	Age	150.267	150.267	201.031	**<0.001**	a. R Squared = .576
	GEN	1.449	1.449	1.938	0.166	(Adjusted R Squared = .571)
OLZE 48	Age	146.396	146.396	198.875	**<0.001**	a. R Squared = .556
	GEN	0.888	0.888	1.207	0.274	(Adjusted R Squared = .550)



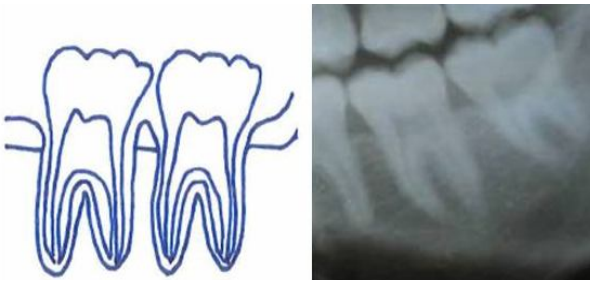
Stage A: Occlusal plane covered with alveolar bone



Stage B: Alveolar eruption; complete resorption of alveolar bone over occlusal plane



Stage C: Gingival emergence; penetration of gingiva by atleast one dental cusp



Stage D: Complete emergence in occlusal plane

Fig. 1: Schematic representation of stages in olze method

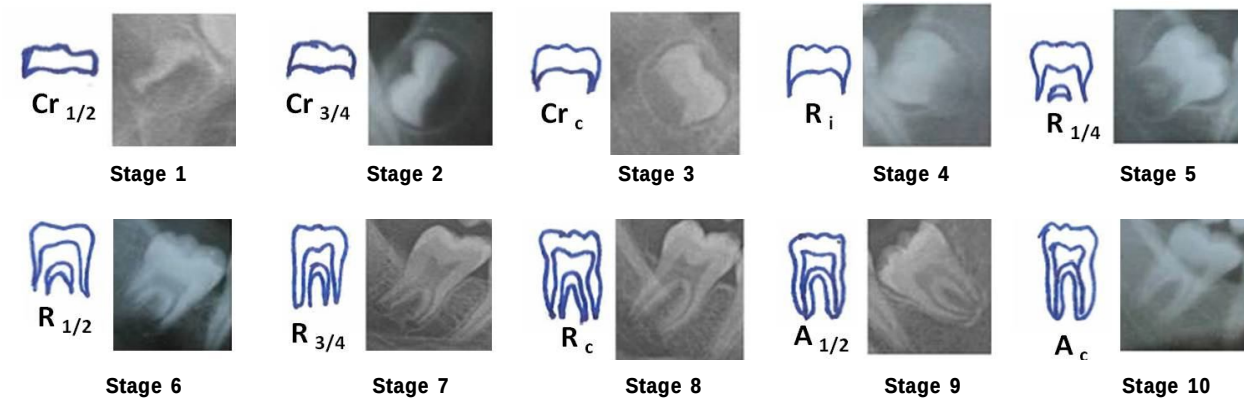
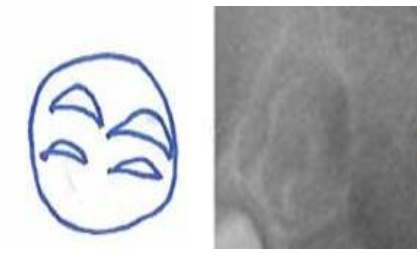
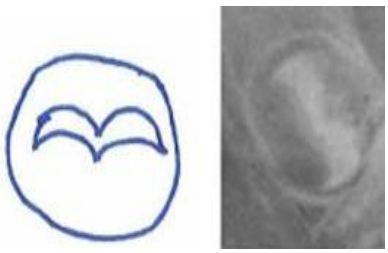


Fig. 2: Schematic representation of stages in gleiser and hunt method

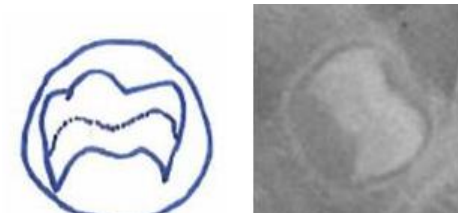


Stage A: Cusp tip are mineralized but have not yet coalesced.



Stage B: Mineralized cusps are united so the mature coronal morphology is well defines.

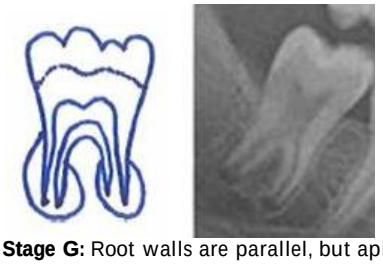
Stage C: The crown is about half formed, the pulp chamber is evident and dentinal deposition is occurring.



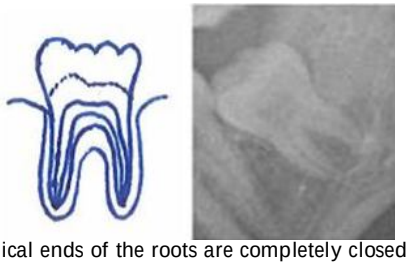
Stage D: Crown formation is complete to the dentino-Enamel junction. The pulp has a trapezoidal form.

Stage E: Formation of inter-radicular bifurcation has begun. Root length is less than the crown length.

Stage F: Root length is atleast as great as crown length. Roots have funnel shaped endings.



Stage G: Root walls are parallel, but apices remain open.



Stage H: Apical ends of the roots are completely closed and the periodontal membrane has a uniform width around the root.

Fig. 3: Schematic representation of stages in demirjian method

Discussion

Eruption of the second molar marks the age of an individual around 14 years. By 15 years of age, the apices of the majority of the permanent teeth have closed, with only the third permanent molars remain as immature teeth. Age estimation using sequence of tooth eruption is impossible for an individual more than 18 years. The third molar shows considerable variation in its development and is the tooth most commonly developmentally absent. Prevalence data for absence of the third permanent molar varies from 7-32% in the population.

The third permanent molar has been shown to be more variable than the other permanent teeth, and is not included in the originally proposed method by Demirjian. There are significant morphological and anatomic differences between the maxillary and mandibular third molars namely the number of roots, the angulation etc. With caution, all available third permanent molars should be used in age determination.

Assessment of tooth eruption is quick and non-invasive method which can be determined by clinical examination or radiographic evaluation. A wide range of eruption age in of teeth affected by factors such as the space available, ankylosis and early or delayed extraction of primary teeth alter the normal eruption of the permanent successors etc are the major disadvantages [12,13].

Assessment of the level of calcification of tooth on dental radiographs can be used to predict the age of the individual. Initially, extra-oral lateral oblique radiographs or cephalographs and intra-oral radiographs were required to view the developing permanent teeth. OPG allow the visualization of all the permanent teeth at one time, with reduced exposure to radiation.

Various methods have been employed which divide the tooth development into as many as 22 stages (Schour & Massler) to as less as 3 stages (Garn et al.)[4,5]. Advantage of fewer stages is better reliability of inter-examiner agreement, but less precision of age estimation. In contrast, having more

stages improves the accuracy of age estimation, but results in poor repeatability.

Whilst the majority of studies have used the Demirjian technique and there is still no consensus as to which is the best approach. The system devised by Demirjian, Goldstein and Tanner (1973) and later modified (Demirjian & Goldstein 1976) assessed the 7 left permanent mandibular teeth discernible, dividing each tooth into eight developmental stages[14,15]. No stage was allocated for crypt formation. In addition, third molars were excluded as they were considered to show great variation. The Demirjian technique is easy to use and reproducible, but the limited number of stages particularly of root development, may affect the accuracy of age estimation.

In our study, the mandibular teeth showed better agreement with the stages than the maxillary teeth. This could be attributed to the pattern of eruption of the third molars [16]. Maxillary molars are more likely to be distoangularly impacted [17]. As the maxillary arch flares outward during growth there may be higher incidence of buccal tilt of the maxillary third molars[18]. This buccally inclined third molar might lead to improper assessment of the root developmental stage as the root may look smaller in two dimensional radiograph. This might lead to the higher errors in assessment of the maxillary tooth developmental stages and thereby lesser correlation. Mandibular teeth on the other hand are more likely to be impacted mesioangularly and less of buccal or lingual tooth rotations owing to the buccal and lingual buttress leading to a better scoring.

In the present study, when evaluating the influence of sex on the development of third molar teeth there was no significant difference in the calcifications stage or eruption of third molar teeth between male and female subjects. Influence of gender on the development of the third molar has conflicting results in the literature [8,19]. This may be attributed to ethnic differences in the chronology of third molar mineralization [8].

Conclusion

The technique by gleiser and Hunt has categorized the development to ten stages. This makes it more reliable in predicting the age. But has drawbacks of being more subjective and higher variability. Olze technique on the other hand is more reproducible but has drawback of inability to assess in an impacted teeth. Overall, assessment by all three techniques may give a more reliable age range of prediction. In the present study, gender has no influence in calcification stages or eruption of third molar teeth.

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