

An evaluation of third molar eruption for assessment of chronologic age: A panoramic study

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Abstract

Objectives: The identity of a person can be established by assessing one's age, and in order to be entitled to civil rights and social benefits, verification of the chronological age is required and thereby age estimation has gained an increasing significance in recent years. Tooth eruption is one of the criteria of developmental morphology that can be evaluated by either clinical examination or by evaluation of dental radiographs to determine the dental age. The present study was aimed to evaluate the reliability of the third molar eruption stage as a parameter for forensic age estimation in living subjects. **Materials and Methods:** The stage of wisdom tooth eruption in 77 male and 73 female Indian subjects aged between 12–26 years was determined by subjecting them to conventional orthopantomograms and was interpreted to assess the third molar eruption stages to evaluate the dental age. **Results:** Predicted minimum age and mean age of the study sample were found to be significant predictors ($P < 0.001$) of actual age. Minimum age was able to explain 58.3% of the variation in actual age and the mean age was able to explain 60.3% of variation in actual age. **Conclusion:** Third molar is fairly a reliable indicator to determine the age of alveolar, gingival, and complete emergence of third molar in the occlusal plane in adolescents and young adults. Minimum and most probable ages of examined subjects can also be evaluated using third molar eruption stage.


Key words: Age estimation, dental age, tooth eruption, third molar

Introduction

We are aware that the identity of a person can be established by assessing one's age, which is a procedure adopted by many anthropologists, archaeologists, and forensic experts.^[1] Age assessment in young children is more precise as

multiple teeth are in their various stages of development and even other skeletal maturity factors can be utilized, whereas in case of adolescents and young adults, third molars are the only teeth developing and all other methods to assess age are of questionable value as the fusion of sutures, fusion of epiphysis of bones, and attainment of secondary sex characteristics have already been taken place by middle teens and early twenties. In a nutshell, there is no biological criterion to estimate the chronological age of a person in adolescence and adults.^[2,3] Therefore, when no valid document with the recorded age is available then third molar becomes most useful to determine the juvenile and adult status of an individual.^[2] Also it has been noticed that the maxillary third molar tends to develop somewhat faster than their mandibular counterparts. It is therefore necessary to examine both the maxillary and the

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mandibular third molars to provide a better estimation of the chronological age than using them simply.^[2]

Materials and Methods

A total of 150 Indian subjects (77 male and 73 female) from the ages 12–26 years were subjected to orthopantomograms at the department of oral medicine and radiology, during the year 2009-2010 using film-screen combination of T-MAT G/RA as per the guidelines of the manufacturer of Soredex CRANEX® Excel Ceph Panoramic machine. The identification number, gender, date of birth, and X-ray examination date of each subject were documented, and the eruption stages of the third molars were determined. Age of each subject was confirmed by school/college records or by birth certificate. The age of each subject was calculated as the date of X-ray minus the date of birth. Orthopantomogram was assessed for the eruption stage of the third molar and further the radiographic appearance of the stage of the third molar was compared to the illustration given by Olze A. *et al.*,^[4,5] for staging the eruption status and based on the assessed eruption stage of the third molars, the age of the subject was predicted. The predicted age was recorded in the proforma, which also included the chronological age. Finally, the chronological age, the eruption stage of the third molar and the predicted age were subjected to statistical analysis which was performed using a Statistical Package for the Social Sciences (SPSS) software version 13 by t-test and regression analysis was used to predict actual age using minimum age and mean age as individual predictors.

The following staging system given by Olze *et al.*,^[4,5] was used for classification of third molar eruption [Figures 1-3].

Stage A: Occlusal plane covered with alveolar bone.

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

Stage C: Gingival emergence; penetration of gingiva by at least one dental cusp.

Stage D: Complete emergence in occlusal plane.

The subjects exhibiting following conditions were not included in the study:

1. Impacted third molar teeth and third molar mesially, distally and vestibulo-orally angulated were classified as impacted as recommended by Archer^[6] and Wolf and Haunfelder^[2]
2. Third molar with unclear direction of emergence
3. History of trauma to head and neck region
4. Traumatic injuries of the jaws
5. Malnutrition
6. Congenital abnormalities affecting jaws
7. Endocrine disorders
8. Muscular hypotonia
9. Degenerative disorders

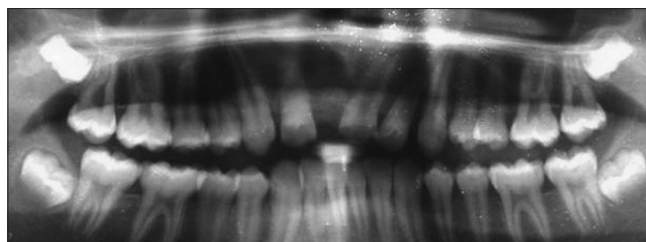


Figure 1: Cropped orthopantomograph - Tooth 18, 28, 38, 48 in stage A

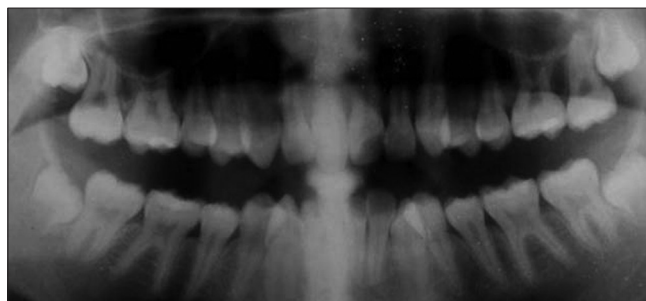


Figure 2: Cropped orthopantomograph - Tooth 18, 28 in stage A and 38, 48 in stage B

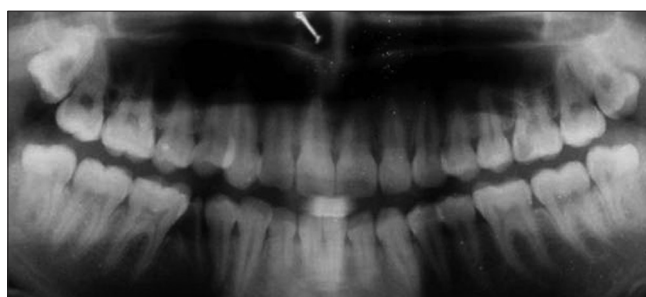


Figure 3: Cropped orthopantomograph - Tooth 18 in stage C and 28, 38, 48 in stage D

The subjects were divided into 3 groups (I to III) [Table 1], grouped at an interval of five years.

Group – I: Consisted of 33 subjects (14 male and 19 female) with age ranged from 12 to 16 years.

Group – II: Consisted of 43 subjects (25 male and 18 female) with age ranged from 17 to 21 years.

Group – III: Consisted of 74 subjects (38 male and 36 female) with age ranged from 22 to 26 years.

Results

Tables 2 and 3 show the number of cases, minimum, maximum, and mean values with standard deviation ranges, and median values with lower and upper quartiles for the age of eruption of teeth 18, 28, 38, and 48 according to eruption stage for male and female, respectively.

In our study, the minimum age of alveolar emergence of the wisdom teeth ranged from 14.6 to 16.2 years in female and from 15.1 to 18.3 years in male. The mean age of alveolar emergence ranged from 16.9 to 19 years in women and from 19.0 to 21.7

years in men. The corresponding standard deviation ranges were 2.3 – 3.3 years and 2.8 – 4.1 years, respectively.

The minimum age of gingival emergence was 14.6–19.0 years in female and 19.5–25.1 years in male. The most probable age of gingival emergence was 17.6–21.9 years

Table 1: Shows no significant association between gender and group ($P>0.05$)

Group	Gender		Total	χ^2	P value
	Male	Female			
Group I	14	19	33	1.846	0.397
Group II	25	18	43		
Group III	38	36	74		
Total	77	73	150		

in women and 21.5–25.1 years in men. The corresponding standard deviation ranges were 2.2–3.6 years and 1.3–2.4 years, respectively.

The minimum age for complete emergence of the wisdom teeth in the occlusal plane was 14.6–15.5 years in women and 16.5 years in men. Statistically significant differences between the genders were observed for tooth 18 and 28 in stage B. There was no statistical difference in mean age between male and female in Stage A, Stage C, and Stage D for tooth 18, 28, 38, and 48, Stage B for tooth 38 and 48, and the comparison in stage C of tooth 38 and 48 could not be carried out as there was only one and none male sample, respectively. Hence, it can be suggested that this method of age estimation using third molar cannot be used to

Table 2: Table shows the number of cases, minimum, maximum and mean values with standard deviation ranges, and median values with lower and upper quartiles for the age of eruption of teeth 18, 28, 38 and 48 according to eruption stage for males

Tooth	Stage	n	Min.	Max.	Mean	S. D.	LQ	Median	UQ
18	A	14	11.50	15.91	13.65	1.42	12.58	13.25	15.20
	B	5	18.33	25.33	21.75	3.13	19.17	20.25	25.08
	C	4	19.58	25.16	21.58	2.47	19.81	20.79	24.14
	D	54	16.58	26.25	22.60	2.37	21.06	23.12	24.33
28	A	14	11.50	15.91	13.65	1.42	12.58	13.25	15.20
	B	6	18.33	25.33	21.54	2.85	19.58	20.38	24.96
	C	2	23.25	25.16	24.21	1.35	23.25	24.21	
	D	55	16.58	26.25	22.50	2.39	21.00	22.83	24.25
38	A	12	11.50	15.91	13.39	1.36	12.58	13.00	14.41
	B	6	15.16	25.33	19.07	3.78	15.29	19.17	21.52
	C	1	25.16	25.16	25.16		25.16	25.16	25.16
	D	58	16.58	26.25	22.52	2.36	20.88	22.96	24.33
48	A	12	11.50	15.91	13.39	1.36	12.58	13.00	14.41
	B	6	15.16	25.33	19.61	4.15	15.29	19.29	23.77
	D	59	16.58	26.25	22.51	2.39	20.50	22.83	24.58

n: Number of cases; Min: Minimum age; Max: Maximum age; SD: Standard deviation; LQ: Lower quartile; UQ: Upper quartile

Table 3: Table shows the number of cases, minimum, maximum and mean values with standard deviation ranges, and median values with lower and upper quartiles for the age of eruption of teeth 18, 28, 38 and 48 according to eruption stage for females

Tooth	Stage	n	Min	Max	Mean	S. D.	LQ	Median	UQ
18	Stage A	17	12.16	23.25	14.55	3.10	12.46	13.50	15.21
	Stage B	5	14.66	22.16	16.93	3.02	14.91	16.25	19.29
	Stage C	5	19.08	24.08	21.56	2.22	19.46	21.25	23.83
	Stage D	46	15.50	26.58	22.60	2.46	21.00	22.58	24.62
28	Stage A	17	12.16	23.25	14.55	3.10	12.46	13.50	15.21
	Stage B	6	15.16	21.25	17.58	2.75	15.42	16.33	21.00
	Stage C	3	18.08	24.08	20.41	3.21	18.08	19.08	
	Stage D	47	14.66	26.58	22.67	2.42	21.66	22.66	24.58
38	Stage A	13	12.16	15.16	13.14	0.94	12.41	12.91	13.62
	Stage B	8	14.66	23.66	18.12	3.37	15.18	17.42	21.31
	Stage C	4	19.08	25.50	21.98	3.15	19.21	21.67	25.06
	Stage D	48	15.50	26.58	22.41	2.53	21.00	22.50	24.14
48	Stage A	14	12.16	15.25	13.29	1.07	12.41	12.96	13.91
	Stage B	4	16.25	21.91	19.06	2.34	16.83	19.04	21.31
	Stage C	5	14.66	23.75	17.61	3.68	14.91	16.41	20.92
	Stage D	50	15.50	26.58	22.58	2.37	21.00	22.58	24.27

n: Number of cases; Min: Minimum age; Max: Maximum age; SD: Standard deviation; LQ: Lower quartile; UQ: Upper quartile

differentiate gender because there was no consistency in the findings when gender was compared, although, the females were approximately 1.3–3.6 years ahead of the males at the different eruption stages of the third molar.

Discussion

Age estimation also plays an important role in anthropological research and treatment planning of various abnormalities. Legal consequences can be quite different if a subject of unknown age is judged to be juvenile or an adult.^[2,3] Changes in bone structure and teeth are more appreciable indices of age. Normally, well defined skeletal development in the leg bones, joints, and cranial sutures takes place at specific ages. However, these changes may be significantly affected by genetics, the general health of the individual, and other environmental factors.^[7] The dentition perhaps more than any other structure in the body reflects the physiological history of an individual, and offers the most reliable basis for age assessment from approximately 10 weeks of intrauterine life up to old age.^[2,7] Teeth are naturally preserved long after all the tissues and even bones have disintegrated and hence are generally reliable for estimation of age.^[1-3,8] Unlike teeth, bone cannot be inspected directly in living individuals.^[8,9] Also, teeth are highly resistant to severe insults such as chemicals, fire, cold, and heat.^[10]

In the present study, the dental age was assessed using the stage of eruption of third molar as suggested by Olze *et al.*,^[4,5] as we all know that third molar is the only developing tooth after the age of approximately 14 years.^[10,11] Its development tends to continue over a long period and until later age.^[6] It appears that formation of third molar is not different in males and females.^[10,11] Further formation is also not related to somatic growth and sexual maturation.^[10,11] All other permanent teeth are characteristically earlier in formation and eruption in the female.^[10] Nevertheless, the third molar tooth is exceptional with no sexual difference in either calcification or eruption.^[10] Therefore, a third molar assumes great forensic importance being unique among human teeth.^[10]

With the completion of development of all teeth by about 16 years, the third molars remain the only tooth that continues to develop. Consequently, radiographic evaluation of third molars is one of the two parameters for age estimation in adolescents and young adults (Arany *et al.*),^[10] the other being morphological examination of skeletal features. The third molar is the most variable tooth in many respects and not an ideal development marker; however, in the absence of other biological indicators of age in the late-teens and early adulthood, they are used to estimate age (Mincer *et al.*),^[10] The studies conducted by Levesque *et al.*,^[4,5] and Muller HR (1983)^[4,5] only provided the data on the ages of

alveolar and gingival emergence of the third molars, whereas our study based on the method suggested by Olze *et al.*,^[4,5] provides the same information as well as data on the age of emergence of the wisdom teeth in the occlusal plane. By our study, we were able to estimate the age of examined subjects based on the four stages of eruption of the third molars as suggested by Olze *et al.*,^[4,5] and determine the minimum and most probable age of the individual [Tables 2 and 3]. This is consistent with the findings of the study conducted by Olze *et al.*,^[4,5] though the minimum and the most probable eruption age as well as the differences between the gender based on the estimated age at particular eruption stage and quadrant of the third molars was not coinciding with our study which could be attributed to the larger sample size and the socio-geographical area. In our study, statistically significant differences were observed between the genders for tooth 18 and 28 in stage B ($P < 0.05$) [Tables 4 and 5]. There was no statistical difference in mean age between males and females in Stage A, Stage C, and Stage D for tooth 18, 28, 38, and 48, Stage B for tooth 38 and 48 and the comparison in stage C of tooth 38 and 48 could not be carried out as there was only one and none male sample, respectively [Tables 6 and 7]. Hence, it can be suggested that this method of age estimation using third molar cannot be used to differentiate gender because there was no consistency in the findings when gender was compared. In our study, the cases in which the gingiva was not clearly discernible and the third molar occlusal surface was at the level of the expected gingiva, the assessment of stage C (gingival eruption) was not made. When the surface of the teeth was clearly above the expected gingiva and below the occlusal plane, the teeth were classified as stage C. As there was only one and none male sample respectively in relation to tooth 38 and 48 and so statistical analysis could not be carried out for stage C in relation to tooth 38 and 48 in our study [Tables 6 and 7]. In our study, the females were approximately 1.3 – 3.6 years ahead of the males at the different eruption stages of the third molar. This finding was not consistent with the findings of the previous studies^[4,5,9,10,12-16] which suggested that males were ahead of the females. This could be attributed to the fact that our study was conducted on Indian population, whereas previous similar studies^[4,5] were conducted on different population. This may also suggest that the difference in the eruption status of third molar in males and females can be attributed to their race. The other reason for the above finding can also be contributed to the unequal gender distribution among the samples in previous studies.^[4,5] In our study, when the correlation between the actual age with minimum age and mean age of the sample was carried out, the minimum age and mean age were both found to be significant predictors ($P < 0.001$) of actual age [Table 8]. Minimum age was able to explain 58.3% of the variation in actual age and mean age was able to explain 60.3% of variation in actual age [Table 9]. This shows that this study based on Olze *et al.*,^[4,5] method to assess the age through the eruption stages of third molar is fairly an accurate predictor

Table 4: Comparison of age between males and females at different stages of eruption in Tooth 18

Eruption stage	Gender	n	Mean	S.D.	Mean difference	t	P value
Stage A	Male	14	13.65	1.42	-0.899	-1.000	0.325
	Female	17	14.55	3.10			
Stage B	Male	5	21.75	3.13	4.820	2.478	0.038*
	Female	5	16.93	3.02			
Stage C	Male	4	21.58	2.47	0.016	0.010	0.992
	Female	5	21.56	2.22			
Stage D	Male	54	22.60	2.37	-0.004	-0.008	0.994
	Female	46	22.60	2.46			

*Denotes significant difference

Table 5: Comparison of age between males and females at different stages of eruption in Tooth 28

Eruption stage	Gender	n	Mean	S.D.	Mean difference	t	P value
Stage A	Male	14	13.65	1.42	-0.899	-1.000	0.325
	Female	17	14.55	3.10			
Stage B	Male	6	21.54	2.85	3.960	2.448	0.034*
	Female	6	17.58	2.75			
Stage C	Male	2	24.21	1.35	3.791	1.517	0.227
	Female	3	20.41	3.21			
Stage D	Male	55	22.50	2.39	-0.165	-0.345	0.731
	Female	47	22.67	2.42			

*Denotes significant difference

Table 6: Comparison of age between males and females at different stages of eruption in Tooth 38

Eruption stage	Gender	n	Mean	S.D.	Mean difference	t	P value
Stage A	Male	12	13.39	1.36	0.249	0.534	0.598
	Female	13	13.14	0.94			
Stage B	Male	6	19.07	3.78	0.945	0.494	0.630
	Female	8	18.12	3.37			
Stage C	Male	1	25.16	—	—	—	—
	Female	4	21.98	3.15			
Stage D	Male	58	22.52	2.36	0.109	0.228	0.820
	Female	48	22.41	2.53			

Table 7: Comparison of age between males and females at different stages of eruption in Tooth 48

Eruption stage	Gender	n	Mean	S.D.	Mean difference	t	P value
Stage A	Male	12	13.39	1.36	0.098	0.205	0.839
	Female	14	13.29	1.07			
Stage B	Male	6	19.61	4.15	0.548	0.237	0.818
	Female	4	19.06	2.34			
Stage C	Male	0	—	—	—	—	—
	Female	5	17.61	3.68			
Stage D	Male	59	22.51	2.39	-0.072	-0.157	0.876
	Female	50	22.58	2.37			

Table 8: Correlation between actual age and minimum age as well as actual age and mean age

Parameter	r	P value
Minimum age	0.765	<0.001*
Mean age	0.777	<0.001*

*Denotes significant correlation

Table 9: Correlation of actual age with minimum age and mean age

Independent variable	Constant	β	R ²	P value
Minimum age	-1.193	1.189	0.583	<0.001*
Mean age	-10.215	1.389	0.603	<0.001*

*Denotes a significant predictor

of the chronological age and is consistent with the findings of the previous studies,^[4-6,10,11,13-17] but it is not consistent with

the findings of Thorson J. and Hagg U. (1991),^[18] which could be attributed to the fact that only mandibular third molars

were used for the estimation of age instead of all the third molars as well as to the method employed in their study for the estimation of age. However, further studies utilizing the similar methods of age estimation is recommended to reconfirm the results obtained in our study.

Conclusion

With the observations made from the study conducted, it is to be suggested that the third molar to an extent is a reliable indicator for age estimation in adolescents and young adults. The age of alveolar, gingival, and complete emergence of the third molars in the occlusal plane provides a useful data that can be utilized for the forensic estimation of the minimum and most probable ages of individuals under investigation. In our study, the females were approximately 1.3–3.6 years ahead of the males at the different eruption stages of the third molar. However, there was absence of any demonstrable gender difference in the stage of eruption of the third molar. Further, in the view of forensic age estimation practice, to reduce margin of error, it would be desirable to combine the assessment of wisdom tooth eruption with other methods as proposed by recommendations of the Study Group on Forensic Age Diagnostics.^[19,20] Further, the studies to be conducted using the same method of age estimation in India is recommended with a larger sample size so as to assess whether demonstrable gender difference exists in the stage of eruption of third molar and to reconfirm the results obtained from our study.

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