Received: 28th September 2015 Accepted: 25th December 2015 Conflict of Interest: None

Source of Support: Nil

Original Research

Age Estimation Using Radiographic Stages of Third Molar in Odisha Population

R Sujatha[1], Bala Subramanya Goutham[2], Kanika Singh Dhull[3], Indira Meda[4], Suvarna Manthapuri[5], Chandra Shekar Poosarla[6]

Contributors:

[1]Senior Lecturer, Department of Oral Pathology and Microbiology, Kalinga Institute of Dental Sciences, Bhubaneswar, Odisha, India; [2]Reader, Department of Public Health Dentistry, Kalinga Institute of Dental Sciences, Bhubaneswar, Odisha, India; [3]Reader, Department of Pedodontics and Preventive Dentistry, Kalinga Institute of Dental Sciences, Bhubaneswar, Odisha, India; [4]Senior Lecturer, Department of Oral Pathology and Microbiology, KIMS Dental College & Hospital, Amalapuram, Andhra Pradesh, India; [5]Reader, Department of Oral Pathology and Microbiology, SVS Institute of Dental Sciences, Appanapalli, Mahabubnagar, Telangana India; [6]Reader, Department of Oral Pathology and Microbiology, SIBAR Institute of Dental Sciences, Guntur, Andhra Pradesh, India.

Correspondence:

Dr. Sujatha R. Department of Oral Pathology and Microbiology, Kalinga Institute of Dental Sciences, Bhubaneswar, Odisha, India. Phone: +91-8895519561. Email: sujathagoutham8@gmail.com

How to cite this article:

Sujatha R, Goutham BS, Dhull KS, Meda I, Manthapuri S, Poosarla CS. Age estimation using radiographic stages of third molar in Odisha population. J Int Oral Health 2016;8(2):238-242.

Abstract:

Background: Radiology plays an important role in human age estimation and dental radiography being the most simple, non-destructive technique. Dental age estimation has been widely used to determine the chronological age of adolescents and young adults.

Materials and Methods: A total of 510 digital orthopantomograms of 227 females and 283 males aged between 9 and 25 years were taken, and third molar development was evaluated by Demirjian's tooth mineralization stages (statistical analysis using Mann–Whitney U test was performed to compare the differences in the mineralization stages of males and females and between maxilla and mandible). Comparison of male and females with mean stages in maxilla and mandible were done using Mann–Whitney U test. Probabilities of individuals being older than 10, 12, 14, 16, 18, 20, 22, 24 years were also estimated.

Results: Males attained formation Stage H (the apical end of the root canal is completely closed) earlier than females, whereas females attained Stage G earlier than males. Maxillary left molar developed earlier than mandibular left molar in males. 100% probability was seen in Stage H for both maxilla and mandible.

Conclusion: The Demirjian method is most reliable for age assessment using third molar mineralization stages.

Key Words: Age estimation, demirjian method, Orthopantomograms

Introduction

Age estimation plays an important role in forensic science. Teeth remain as a useful material for age estimation. The morphological and radiological examination of third molars make up a part of the dental treatment including orthodontic, pedodontic, and surgical treatments by providing valuable information for the clinicians.[1] Late in adolescence, after formation of the premolars and canines, third molars are the only teeth that continue to develop. According to several studies, although the third molars are the most variable teeth in the dentition, still they remain to be the most reliable biological indicator for estimation of age during middle teens and early twenties.[2]

Forensic age diagnosis is applicable in persons without valid identifying documents.[3] Determining chronologic age in persons within the range of 15.5-23.5 years is difficult as skeletal indicators, such as diaphysis-epiphysis fusion, hand-wrist examination, cervical vertebrae assessment, amino acid racemization, sternoclavicular bones, changes in the pubic symphysis, fusion of cranial sutures, or changes in secondary sex characteristics, have their advantages and limitations but are more or less indecisive, especially during these years.[4-8] So, the radiographic assessment of the degree of third molar formation is a major part for forensic age estimation of adolescents and young adults. Several methods were used in the past to assess dental mineralization.[9,10]

In the present study, we chose the eight-stage scheme (Figure 1) designed by Demirjian *et al.*[10] which has been widely known for its simplicity, accuracy, and comprises of clearly defined changes in shape that do not require speculative estimation.[11] It performs well in terms of both observer agreement and correlation between estimated age and true age.[12]

The aim of this study was to determine the developmental stage of third molars in digital panoramic radiographs using the modified Demirjian's chart in Odisha population and to estimate chronological age based on the dental developmental stage of third molars. This study has been done taking into consideration that not many studies have been conducted to correlate the development of wisdom teeth and estimation of age in Odisha population.

Materials and Methods

The retrospective study sample consisted of 510 digital orthopantomograms (OPG) of 227 (44.50%) females and 283 (55.49%) males aged between 9 and 25 years. The

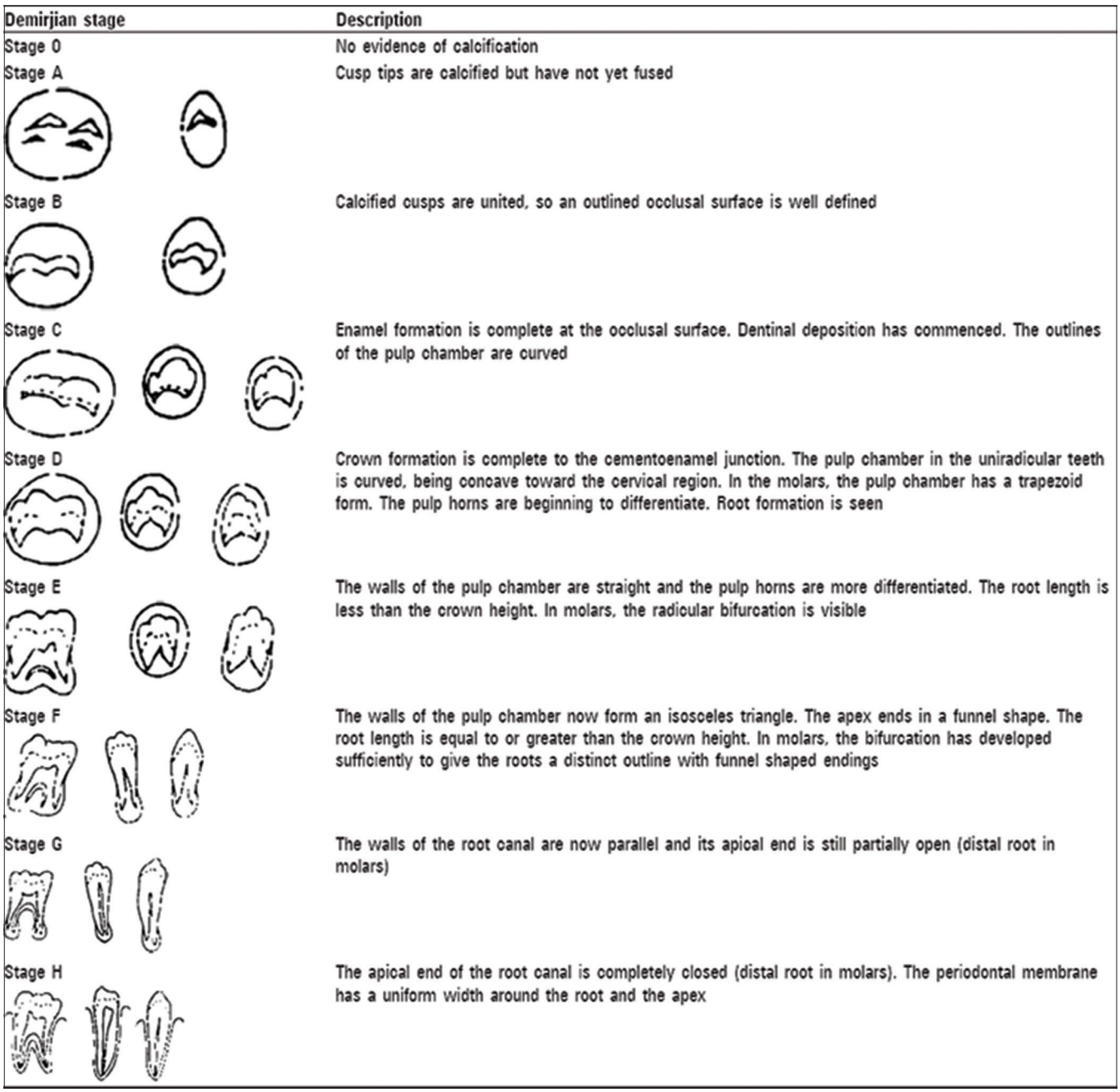

Figure 1: Schematic drawings of the eight formation stages of tooth development (modified from Demirjian *et al.*) courtesy Szilvia Arany.

radiographs were randomly chosen with the approval of institutional ethical committee. The study was carried out in the Department of Oral Radiology, Kalinga Institute of Dental Sciences, Bhubaneswar. Table 1 shows the distribution of OPG's by gender and age group. All the selected OPG's were evaluated separately for each quadrant and gender using the formation stages given by Demirjian *et al.*[11] The scores were determined by two observers without the knowledge of age and gender. To evaluate the variation between independent observers, individual differences were included. To assess the reliability, 150 OPG's were selected randomly and re-examined One month after the initial examination by the same observers.

The inclusion criteria were the adequate quality of OPG's, people, who are native of Odisha, presence of all the four third molars, no history of medical or surgical disease that could affect the development of third molars. Exclusion criteria were OPG's with poor image quality, any pathology affecting the development of third molars and OPG's with any missing third molar. Statistical analysis was done using statistical package for social sciences 20.0.

Table 1 presents the age and sex distribution in detail. Mean age for all the eight developmental stages were calculated. Comparison of male and females with mean stages in maxilla and mandible were done using Mann–Whitney *U* test.

Table 1: Distribution of subjects by gender at different ages.

Age	Male	%	Female	%	Total	%
9	4	0.78	4	0.78	8	1.57
10	11	2.16	6	1.18	17	3.33
11	11	2.16	4	0.78	15	2.94
12	2	0.39	1	0.20	3	0.59
13	8	1.57	3	0.59	11	2.16
14	29	5.69	3	0.59	32	6.27
15	19	3.73	25	4.90	44	8.63
16	23	4.51	23	4.51	46	9.02
17	18	3.53	18	3.53	36	7.06
18	15	2.94	10	1.96	25	4.90
19	19	3.73	19	3.73	38	7.45
20	23	4.51	13	2.55	36	7.06
21	19	3.73	23	4.51	42	8.24
22	33	6.47	26	5.10	59	11.57
23	42	8.24	44	8.63	86	16.86
24	2	0.39	2	0.39	4	0.78
25	5	0.98	3	0.59	8	1.57
Total	283	55.49	227	44.51	510	100.00

Table 2: Mean ages (with 95% CIs) of Demirjian's stages (18 and 28).

Stages	Males					
	18			28		
	Mean	SD	95% CI	Mean	SD	95% CI
A	10.82	0.60	10.41-11.22	10.82	0.60	10.41-11.22
B	12.30	2.23	11.47-13.13	11.96	2.01	11.13-12.79
C	14.59	2.31	13.68-15.51	14.29	2.37	13.42-15.16
D	16.22	2.69	15.16-17.29	15.45	1.60	14.75-16.16
E	18.20	2.91	17.27-19.13	18.28	3.10	17.23-19.33
F	19.26	2.85	18.38-20.13	18.93	2.79	18.09-19.77
G	21.64	2.01	20.92-22.35	20.92	2.15	20.30-21.54
H	21.18	2.09	20.69-21.67	21.55	1.89	21.08-22.02
Total	18.07	4.11	17.59-18.55	18.07	4.11	17.59-18.55

CI: Confidence intervals, SD: Standard deviation

Results

Statistical analyzes showed no significant inter or intra-observer differences on repeated scoring done on 150 subsamples after 1 month ($P > 0.05$). Means of all the eight different developmental Stages (A to H) of the third molars were examined in both males (Tables 2 and 3) and females (Tables 4 and 5). Males and females were compared for each stage of all third molars by Mann–Whitney *U* test (Table 6). A significant difference was observed in third molar development between males and females with respect to Stage A (18, 28); D (38); E (38); G (18, 28, 38, 48), and H (18, 38, 48). Males attained formation Stage "H" for 18; "D," "H" for 38, and "H" for 48 earlier than females. Contrast results were observed for Stages "A," "G" of 18, 28; "E," "G" of 38; "G" of 48 where females showed development earlier than females. Third molar development was compared between maxilla and mandible in both genders by Mann–Whitney *U* test. Maxillary left molar developed earlier than mandibular left molar in males (Table 7). Probabilities of an individual being older than 10, 12, 14, 16, 18, 20, 22, 24 years were also estimated (Table 8).

Table 3: Mean ages (with 95% CIs) of Demirjian's stages (38 and 48).

Stage	Males					
	38			48		
	Mean	SD	95% CI	Mean	SD	95% CI
A	11.50	1.64	9.78-13.22	9.75	0.50	8.95-10.55
B	11.27	1.71	10.58-11.96	11.52	1.53	10.91-12.12
C	13.93	2.09	13.12-14.74	13.67	2.37	12.67-14.67
D	15.17	1.46	14.55-15.79	15.07	1.33	14.55-15.60
E	18.03	2.78	16.98-19.09	18.07	2.71	16.57-19.57
F	17.65	2.77	16.53-18.77	17.55	2.76	16.67-18.43
G	20.59	2.41	20.03-21.15	20.60	2.57	19.96-21.24
H	21.32	2.12	20.82-21.83	21.21	2.03	20.76-21.66
Total	18.07	4.11	17.59-18.55	18.07	4.11	17.59-18.55

CI: Confidence intervals, SD: Standard deviation

Table 4: Mean ages (with 95% CIs) of Demirjian's stages (18 and 28).

Stage	Females					
	18			28		
	Mean	SD	95% CI	Mean	SD	95% CI
A	9.86	0.90	9.03-10.69	9.40	0.55	8.72-10.08
B	12.14	2.12	10.19-14.10	12.18	2.75	10.33-14.03
C	15.19	3.43	13.63-16.75	14.21	2.52	12.76-15.67
D	16.19	1.96	15.40-16.98	16.33	1.96	15.56-17.11
E	18.47	2.22	17.72-19.22	18.56	2.22	17.68-19.44
F	18.56	2.35	17.59-19.53	18.70	2.34	17.92-19.48
G	19.00	2.83	17.83-20.17	18.96	2.96	17.68-20.24
H	22.19	1.39	21.88-22.50	21.96	1.79	21.57-22.35
Total	18.82	3.80	18.33-19.32	18.82	3.80	18.33-19.32

CI: Confidence intervals, SD: Standard deviation

Table 5: Mean ages (with 95% CIs) of Demirjian's stages (38 and 48).

Stages	Females					
	38			48		
	Mean	SD	95% CI	Mean	SD	95% CI
A	9.50	0.71	3.15-15.85	9.00	-	-
B	12.29	3.12	10.48-14.09	12.38	3.23	10.43-14.34
C	14.25	3.02	12.64-15.86	14.00	2.94	12.49-15.51
D	16.60	2.72	15.09-18.11	15.30	2.36	13.61-16.99
E	16.32	1.39	15.78-16.86	16.35	1.73	15.46-17.24
F	18.57	1.95	17.72-19.41	17.65	2.30	16.97-18.34
G	18.75	2.36	17.95-19.55	19.41	2.23	18.57-20.26
H	22.00	1.69	21.65-22.35	21.90	1.78	21.54-22.27
Total	18.82	3.80	18.33-19.32	18.82	3.80	18.33-19.32

CI: Confidence intervals, SD: Standard deviation

Discussion

The importance of age estimation has increased over the years, especially of living persons for a legal perspective. 66 age estimates were executed to determine whether a suspect without legal identification documents has criminal liability or whether the general criminal law in force for adults is to be applied in a particular case. For children, age estimation can be carried out according to the mineralization stages of the seven permanent teeth starting from incisors to their second molars.[13] Whereas for late adolescence and early adulthood, the third molar is the only tooth still being under developed and is the tooth to study for age estimation. Different classification systems were given by different authors, dividing mineralization

Table 6: Comparison of males and females in each stage of 18, 28, 38, and 48 by Mann–Whitney U test.

Stages	Male versus females in 18		Male versus females in 28		Male versus females in 38		Male versus females in 48	
	Z value	*P* value	*Z* value	*P* value	*Z* value	*P* value	*Z* value	*P* value
A	−2.2080	0.0270*	−2.9550	0.0030*	−1.6430	0.1000	−1.2250	0.2210
B	−0.1000	0.9210	−0.1050	0.9160	−0.6690	0.5040	−0.2810	0.7790
C	−0.7970	0.4250	−0.0870	0.9310	−0.5000	0.6170	−0.3640	0.7160
D	−0.8070	0.4200	−1.8540	0.0640	−1.9980	0.0460*	−1.5620	0.1180
E	−0.5310	0.5950	−0.5180	0.6040	−2.5370	0.0110*	−1.7750	0.0760
F	−1.0710	0.2840	−0.3990	0.6900	−1.2760	0.2020	−0.3530	0.7240
G	−3.5390	0.00001*	−2.7350	0.0060*	−3.5830	0.00001*	−2.4360	0.0150*
H	−3.0760	0.0020*	−1.5080	0.1320	−2.1680	0.0300*	−2.4520	0.0140*

*P<0.05

Table 7: Comparison of third molar development in maxilla and mandible by Mann–Whitney U test.

Sex	Tooth	Mean	SD	Sum of ranks	*U* value	*Z* value	*P* value
Male	Tooth 18	5.39	2.20	76944.5			
	Tooth 48	5.72	2.13	83516.5	36758.5	−1.6892	0.0912
	Tooth 28	5.47	2.15	75798.0			
	Tooth 38	5.85	2.11	84663.0	35612.0	−2.2786	0.0227*
Female	Tooth 18	5.87	2.06	49177.5			
	Tooth 48	6.22	2.00	54107.5	23299.5	−1.7635	0.0778
	Tooth 28	5.99	2.01	49249.0			
	Tooth 38	6.32	1.91	54036.0	23371.0	−1.7123	0.0868

*P<0.05. SD: Standard deviation

Table 8: Probabilities of an individual being older than 10, 12, 14, 16, 18, 20, 22, 24 years, estimated by third molar radiological examination.

Age	Sex	Maxilla (%)								Mandible (%)							
		A	B	C	D	E	F	G	H	A	B	C	D	E	F	G	H
10	Male	29	91	100	100	100	100	100	100	27	82	100	100	100	100	100	100
	Female	50	58	100	100	100	100	100	100	8	58	100	100	100	100	100	100
12	Male	27	79	100	100	100	100	100	100	21	74	100	100	100	100	100	100
	Female	33	50	100	100	100	100	100	100	0	50	100	100	100	100	100	100
14	Male	0	0	100	100	100	100	100	100	0	17	55	75	100	100	100	100
	Female	33	33	100	100	100	100	100	100	0	33	67	83	100	100	100	100
16	Male	0	31	63	78	91	100	100	100	0	16	50	72	75	91	100	100
	Female	0	17	100	100	100	100	100	100	0	31	50	75	100	100	100	100
18	Male	0	34	59	76	90	100	100	100	0	0	33	70	72	90	100	100
	Female	0	7	26	35	59	91	96	100	0	0	20	33	52	89	93	100
20	Male	0	0	8	20	54	76	93	100	0	0	8	14	39	85	93	100
	Female	0	3	20	30	57	80	95	100	0	0	13	25	46	87	90	100
22	Male	0	0	4	12	40	70	78	100	0	0	0	11	26	40	82	100
	Female	0	0	14	27	18	40	80	100	0	0	7	22	40	80	87	100
24	Male	0	0	2	10	13	60	63	100	0	0	0	7	9	13	70	100
	Female	0	0	4	7	15	22	52	100	0	0	4	10	13	26	52	100

process of the third molar into a large number of stages which were difficult, to delimit from each other.[14]

The Demirjian method was widely accepted as it is simple and clearly explains the changes in the shape of the tooth which does not overlap with each other. The review of the literature shows that many studies conducted in the past by Orhan *et al.*[11] have verified the correlation between estimated and actual ages using the Demirjian method which was also chosen for the present study. Studies conducted by Bolanos *et al.*[14] on Spanish population and Olze *et al.*[15] on Japanese, and Orhan *et al.*[11] on Turkish population using the Demirjian's classification showed no statistical difference in mineralization levels based on sex which is in contrast to our results.

A study by Meinl *et al.*[2] on Austrian population reported a significant difference between males and females in the development of mandibular third molars. Rai *et al.*[16] also reported a significant difference in third molar development between males and females regarding the calcification Stage D and Stage G which showed the genesis early in females than males, but in our study, we found that Stage D was early in males and G in females. Arany *et al.* study on Japanese population revealed statistically significant differences in the Stages D, E, and G, which were faster in males compared to females. However, in our study, we found H and D stages to be early in males and A, G, E stages to be early in females. Regarding the difference in the development of maxillary and mandibular molars maxillary molars developed earlier than

mandibular molars in males which was in accordance with the studies done by Arany *et al.*[17]

According to the study conducted by Hassan and Hamalia,[18] on Egyptians to detect the chronological age of individuals based on the development of third molars showed that the mean ages of upper and lower right molar, lower left molar were significantly higher in females than in males where as in our study the mean age of mandibular left molars was greater in both females and males when compared to the other molars. Moreover, males showed an insignificant decrease of mean age of upper left molar tooth than females where as our study showed greater mean age for all the third molars in females when compared to males.

Mohammed *et al.*[19] have conducted a study using the modified Demirjian method and concluded that there was a significant correlation between dental age and chronological age and the process of maturation was earlier in females when compared to males which is similar to our study. The Demirjian method was applied in most of the studies all around the world; most of them show the similar pattern of maturity and few with the difference in males and females or difference in maxilla and mandible. This could be the because of the difference in the populations which chosen were from different geographical areas. Still the Demirjian method remains to be the best in the age estimation using OPGs.

Conclusion

Age is one of the essential factors in establishing the identity of the person. Estimation of the human age is a procedure adopted by anthropologists, archaeologists, and forensic scientists. Age estimation of an individual by examination of the developmental stage of third molars using OPG can be a useful tool in the field of legal and forensic medicine. Our data provides references for third molar examination using the Demirjian method in Odisha population. However, studies with larger sample must be conducted which would be helpful in tracing some guidelines concerning the sex of the individual for each age group.

References

1. Golovcencu L, Scripcaru C, Zegan G. Third molar development in relation to chronological age in Romanian children and young adults. Rom J Legal Med 2009;4:277-82.
2. Meinl A, Tangl S, Huber C, Maurer B, Watzek G. The chronology of third molar mineralization in the Austrian population – A contribution to forensic age estimation. Forensic Sci Int 2007;169(2-3):161-7.
3. Greulich WW, Pyle SI. Radiographic Atlas of Skeletal Development of the Hand and Wrist, Stanford, CA: Stanford University Press; 1959.
4. Kreitner KF, Schweden FJ, Riepert T, Nafe B, Thelen M. Bone age determination based on the study of the medial extremity of the clavicle. Eur Radiol 1998;8(7):1116-22.
5. Tanner JM, Whitehouse RH, Marshall WA, Healy MJ, Goldstein H. Assessment of Skeletal Maturity and Prediction of Adult Height (TW2 Method), London, England: Academic Press; 1975.
6. Mörnstad H, Pfeiffer H, Teivens A. Estimation of dental age using HPLC-technique to determine the degree of aspartic acid racemization. J Forensic Sci 1994;39(6):1425-31.
7. Nambiar P, Yaacob H, Menon R. Third molars in the establishment of adult status – A case report. J Forensic Odontostomatol 1996;14(2):30-3.
8. Kullman L, Johanson G, Akesson L. Root development of the lower third molar and its relation to chronological age. Swed Dent J 1992;16(4):161-7.
9. Mesotten K, Gunst K, Carbonez A, Willems G. Dental age estimation and third molars: A preliminary study. Forensic Sci Int 2002;129(2):110-5.
10. Demirjian A, Goldstein H, Tanner JM. A new system of dental age assessment. Hum Biol 1973;45(2):211-27.
11. Orhan K, Ozer L, Orhan AI, Dogan S, Paksoy CS. Radiographic evaluation of third molar development in relation to chronological age among Turkish children and youth. Forensic Sci Int 2007;165(1):46-51.
12. Bagherpour A, Imanimoghaddam M, Bagherpour MR, Einolghozati M. Dental age assessment among Iranian children aged 6-13 years using the Demirjian method. Forensic Sci Int 2010;197(1-3):121.e1-4.
13. Chen JW, Guo J, Zhou J, Liu RK, Chen TT, Zou SJ. Assessment of dental maturity of western Chinese children using Demirjian's method. Forensic Sci Int 2010;197(1-3):119.e1-4.
14. Bolanos MV, Manrique MC, Bolanos MJ, Briones MT. Approaches to chronological age assessment based on dental calcification. Forensic Sci Int 2000;110(2):97-106.
15. Olze A, Taniguchi M, Schmeling A, Zhu BL, Yamada Y, Maeda H, *et al.* Studies on the chronology of third molar mineralization in a Japanese population. Leg Med (Tokyo) 2004;6(2):73-9.
16. Rai B, Kaur J, Anand SC. Mandibular third molar development staging to chronologic age and sex in north Indian children and young adults. J Forensic Odontostomatol 2009;27(2):45-9.
17. Arany S, Iino M, Yoshioka N. Radiographic survey of third molar development in relation to chronological age among Japanese juveniles. J Forensic Sci 2004;49(3):534-8.
18. Hassan NA, Hamalia NA. Orthopantomography and age determination using third molar mineralization in a sample of Egyptians. J Forensic Med Clin Toxicol 2007;xv(1):45-60.
19. Mohammed RB, Koganti R, Kalyan SV, Tircouveluri S, Singh JR, Srinivasulu E. Digital radiographic evaluation of mandibular third molar for age estimation in young adults and adolescents of South Indian population using modified Demirjian's method. J Forensic Dent Sci 2014;6(3):191-6.