

Forensic Age Estimation Using Demirjian Method in Marathwada Population- A Key in Medico-Legal Cases.

¹Dr. Sneha H. Choudhary, B.D.S, M.D.S., Senior Lecturer, Department Of Oral Medicine And Radiology, Teerthanker Mahaveer Dental College and Research Centre, Moradabad, Uttar Pradesh, India.

²Dr. Lata M. Kale, B.D.S, M.D.S. , Professor, Guide And Head, Department Of Oral Medicine And Radiology, C.S.M.S.S. Dental College And Hospital, Aurangabad, Maharashtra, India.

³Dr. Sunil S. Mishra, B.D.S., M.D.S. , Reader, Department Of Oral Medicine And Radiology, Rural Dental College, Loni, Maharashtra, India

⁴Dr. Vishwas D. Kadam, B.D.S., M.D.S., Reader, Department Of Oral Medicine And Radiology, C.S.M.S.S. Dental College And Hospital, Aurangabad, Maharashtra, India

⁵Dr. Narendra B. Supe, B.D.S., M.D.S., Consultant, Oral and Maxillofacial surgery, Buldhana, Maharashtra, India.

⁶Dr. Sheetal Yamyar, B.D.S, M.D.S., Senior Lecturer, Department Of Orthodontics, C.S.M.S.S. Dental College And Hospital, Aurangabad, Maharashtra, India.

Correspondence Author: Dr. Sneha H. Choudhary, B.D.S, M.D.S., Senior Lecturer, Department Of Oral Medicine And Radiology, Teerthanker Mahaveer Dental College and Research Centre, Moradabad, Uttar Pradesh, India.

Conflicts of Interest: Nil

Type of Publication: Case Report

Conflicts of Interest: Nil

Abstract

Context: Age estimation plays a significant role in forensic medicine due to the rapid increase in the incidence of crimes of varied nature, age has become an important factor for assessment in criminal cases like rapes, criminal abortion, infanticide, murder, etc.

Aim: To estimate the age of adolescents and young adults based on Demirjian classification system for the development of mandibular 3rd molars using panoramic radiographs.

Settings and Design: The study was designed as a cross-sectional, observational panoramic study which was carried out in the department of Oral Medicine and Radiology.

Methods and Material: A total of 220 orthopantomographs (OPGs) were used from 220 patients

(94 males and 126 females) in the age range of 14 to 24 years, which were further divided into 11 age groups at an interval of 1 year. Demirjian's staging from OPG was done based on the mineralization stage of the teeth for 38 and 48 in all the patients by two different observers independently to avoid inter-observer bias.

Statistical analysis used: Descriptive statistical analysis, Test of proportion, Chi-square test and Wilcoxon Signed Rank Test.

Results: The development of third molar in all stages was found slightly earlier in females than in males. The initial Demirjian's Stages (C and D) were observed at an earlier age in 48 as compared to 38. Demirjian's Stage H was observed only in patients of 18 years and above.

Conclusion: The mandibular third molar can be used for age estimation in adolescents and young adults using

Demirjian's method for forensic as well as medico-legal purposes.

Key-words: Age estimation, Demirjian's method, Forensic dentistry, Forensic Odontology, mandibular third molar

Introduction

Tooth formation is suitable for estimation of age because it is a continuous, progressive process that can be followed radiographically from crypt stage to root apex closure.^[1]

The most widely used method for age estimation from tooth mineralization on radiograph was first described in 1973 by Demirjian et al.^[2] Third molar becomes most useful to determine the juvenile and adult status of an individual as their development occurs over a longer period of time.^[3] 18 years of age plays a vital role in criminal cases such as according to Section 4(a) of The Hindu Minority and Guardianship Act 1956, a person who is below 18 years of age is a minor and according to section 366-A of Indian penal code (I.P.C), whoever procures any girl under the age of 18 years for the purposes of illicit intercourse with another person, shall be punishable with imprisonment which may extend to ten years and shall also be liable to fine.^[3] Since maxillary third molar roots may be superimposed with anatomical structures present in that region, mandibular third molars can be considered more reliable for age estimation. Thus the present study was conducted with the aim to estimate the age of adolescents and young adults based on Demirjian's system for the development of mandibular third molars using panoramic radiographs in marathwada population.

Subjects and Methods

The study was carried out in the department of Oral Medicine & Radiology, as a cross sectional, observational panoramic study with a sample size of 220 patients (94 males and 126 females) between the age range of 14 to 24

years who were further divided into 11 age groups at an interval of 1 year. The protocol of the study was approved by the Ethical Committee of the institution in November 2013 and informed consent was obtained from each patient accordingly. The present study was carried out from November 2013 to June 2015. The patients were selected based on the following criteria:

Inclusion criteria

- 1) Age 14-24 years.
- 2) Healthy volunteers with no history of disease/syndromes that could affect the presence and development of wisdom teeth.
- 3) No history of any genetic or hereditary diseases.
- 4) Resident of Western India

Exclusion criteria

- 1) Completely edentulous patients.
- 2) Patients with congenitally missing mandibular third molars.

All the patients had undergone complete history taking procedure and clinical examination. Those who met the inclusion criteria were informed in detail about the study and after obtaining an informed consent were taken to the department of Oral Radiology for panoramic imaging. Films were processed under ambient processing conditions. Dried films were placed in separate covers. All the 220 radiographs were studied and graded by two observers independently, to avoid inter-observer bias, for right and left mandibular third molars for the Demirjian's stages of tooth development by comparing the radiographic status of the mandibular third molar in each OPG with the schematic representation and radiographic depiction of the Demirjian's Stages in the chart as described below: (Figure 1)

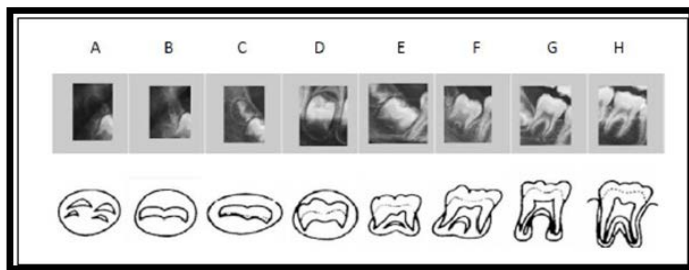


Figure 1: Chart depicting Demirjian's staging of tooth development

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

Stage B: Mineralized cusps are united so the mature coronal Morphology is well defined.

Stage C: The crown is about half formed; the pulp chamber is evident and dentinal deposition is occurring. (Figure 2)



Figure 2: Orthopantomograph showing Demirjian's Stage C (38) and Demirjian's Stage D (48)

Stage D: Crown formation is complete to the dentino-enamel junction. The pulp chamber has a trapezoidal form. (Figure 2)

Stage E: Formation of the inter-radicular bifurcation has begun. Root length is less than the crown length. (Figure 3)



Figure 3: Orthopantomograph showing Demirjian's Stage E (38) and Demirjian's Stage F (48)

Stage F: Root length is at least as great as crown length. Roots have funnel-shaped endings. (Figure 3)

Stage G: Root walls are parallel, but apices remain open. (Figure 4)

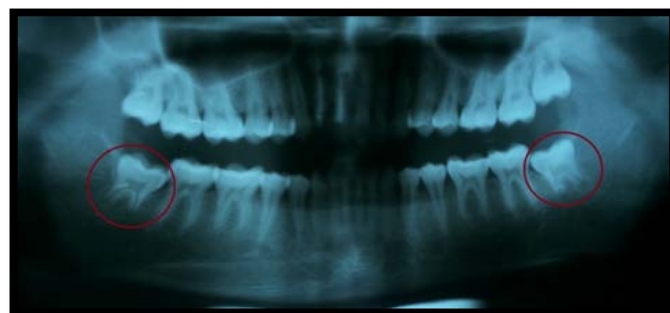


Figure 4: Orthopantomograph showing Demirjian's Stage G (38 and 48)

Stage H: Apical ends of the roots are completely closed. (Figure 5)



Figure 5: Orthopantomograph showing Demirjian's Stage H (38 and 48)

The collected data was tabulated and subjected to statistical analysis. The observations and results were made accordingly.

Results

In the present study, development of third molar in all stages was found slightly earlier in females than in males but the difference in age at the various developmental stages between males and females was statistically insignificant. (Table 1) The mean age of attainment of

Demirjian's Stages C and D was delayed in males than females which revealed that females were in advancement of dental maturity than males in lower age groups, suggesting that the mineralization of crown takes place slightly earlier in females than males. For Demirjian's Stages E, F and G delay in females than males was

observed, suggesting that root formation occurs earlier in males than females. The mean age of attainment of Demirjian's Stage H was found slightly earlier in females than males suggesting that the root apex closure occurs earlier in females than males. However, all these differences were statistically not significant.

Table-1: Average of mean ages of all the patients by Observer 1 and Observer 2

For 38	Demirjian's Stages					
	C	D	E	F	G	H
Male	14.90±1.11	15.15±0.55	16.24±0.94	16.61±1.28	19.08±2.02	22.29±1.48
Female	14.48±0.50	14.78±0.71	16.69±1.71	17.34±2.11	19.56±1.75	22.24±1.85
t-test	0.77	1.24	0.78	1.34	0.92	0.17
p-value	0.61	0.21	0.63	0.13	0.46	0.82
Overall	14.69±0.80	14.96±0.63	16.46±1.32	16.97±1.69	19.32±1.88	22.26±1.66
For 48	Demirjian's Stages					
	C	D	E	F	G	H
Male	14.58±0.00	14.84±0.49	16.48±1.55	17.30±1.49	18.67±1.59	22.39±1.86
Female	14.52±0.99	14.66±0.55	16.53±1.64	17.73±1.96	19.55±1.64	22.30±1.75
t-test	0.14	0.67	0.18	1.04	1.62	0.22
p-value	0.91	0.72	0.83	0.10	0.08	0.81
Overall	14.55±0.49	14.75±0.76	16.50±1.59	17.51±1.72	19.11±1.61	22.34±1.80
Overall for 38 & 48	Demirjian's Stages					
	C	D	E	F	G	H
Male	14.74±0.55	14.99±0.52	16.36±1.24	16.95±1.38	18.87±1.80	22.34±1.67
Female	14.50±0.74	14.72±0.63	16.61±1.67	17.53±2.03	19.55±1.64	22.27±1.80
t-test	0.18	0.14	0.27	1.01	1.52	0.11
p-value	0.88	0.92	0.80	0.11	0.09	0.93
Overall for Male & Female and 38 & 48	Demirjian's Stages					
	C	D	E	F	G	H
	14.62±0.64	14.85±0.57	16.48±1.45	17.24±1.70	19.21±1.70	22.30±1.73

The initial Demirjian's Stages (C and D) were observed at an earlier age in 48 [Figure 6A and 6B] as compared to 38 (Figure 7A and 7B), but later Demirjian's Stages (E-H) were seen comparatively at an earlier age in 38 than 48 which suggest that mineralization of crown occurs earlier in 48 but initiation, formation and completion of root

occurs comparatively earlier in 38. However, this side difference was statistically insignificant. Thus both 38 and 48 can be used as a reliable indicator for age estimation in all age groups using Demirjian's method.

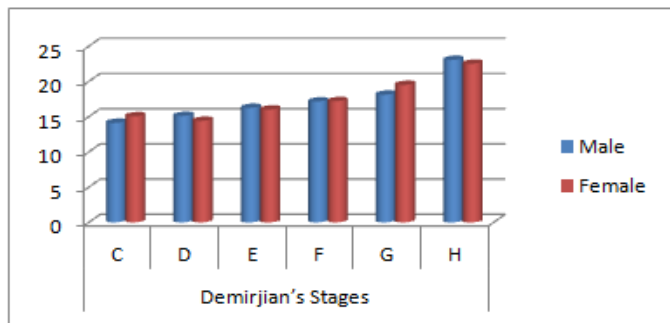


Figure 6A: Graph showing mean age of attainment of Demirjian's Stages in male patients for 48 by Observer 1

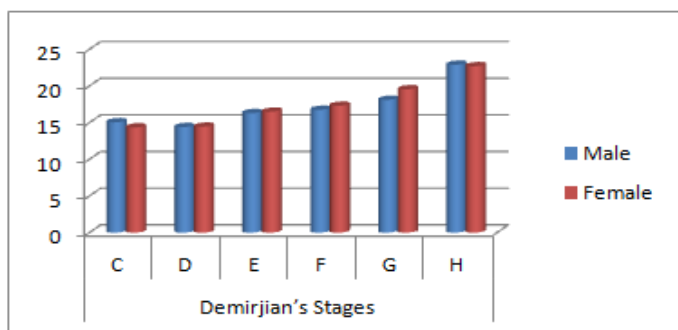
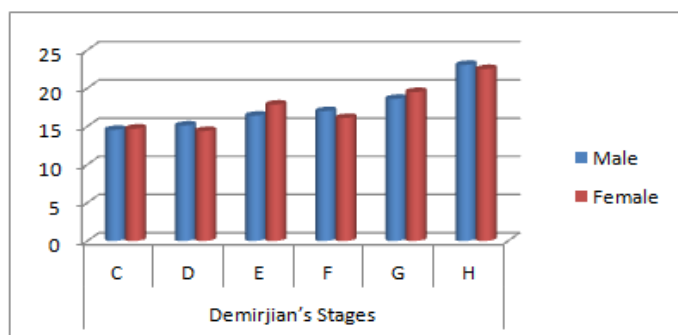


Figure 6B: Graph showing mean age of attainment of Demirjian's Stages in male patients for 48 by Observer 2



7A: Graph showing mean age of attainment of Demirjian's Stages in female patients for 38 by Observer 1

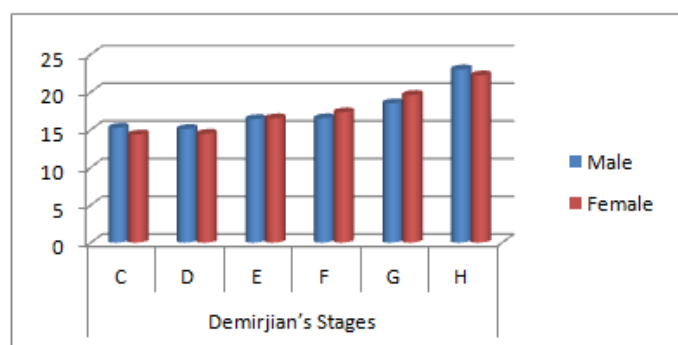


Figure 7B: Graph showing mean age of attainment of Demirjian's Stages in female patients for 38 by Observer 2

In the present study, Demirjian's Stages A and B were not observed in any of the age groups. Demirjian's Stages C and D were observed more frequently in the age group of 14-15 years, while Demirjian's Stages E and F were observed in a wide age range of 14-22 years. Demirjian's Stage G was observed in patients above 16 years of age. Demirjian's Stages C and D were not observed in patients above 16 years of age, whereas Demirjian's Stage G was not observed in patients below 16 years of age. Demirjian's Stage H was observed only in patients of 18 years and above. In medico legal cases, most commonly the question arises whether an individual is a juvenile or an adult, i.e. younger or older than 18 years of age. From the present study, it can be stated that if 38 or 48 is observed to be in Demirjian's Stages A-D, then it is more likely that the individual is below 18 years of age, whereas if 38 or 48 is in Demirjian's Stage H, then the individual is more likely to be of 18 years and above.

Discussion

Various methods for age estimation has been applied and reported previously in literature. Based on the degree of calcification of teeth observed in radiographic examination carried out in permanent dentition, the most popular and widely used method is the one given by Demirjian et al in 1973 which is based on the development of teeth on panoramic radiograph to achieve dental maturity scores. They have categorized the tooth development into 8 stages which is rated on a scale from "A" to "H" on the radiographic images and have given the criteria required for each stage in both uniradicular and multiradicular teeth with the help of schematic representations.^[5] Demirjian's original method was adopted for use on the third molar by Mincer HH et al^[6]

who calculated the likelihood of an individual being at least 18 years of age based on the mean age and standard deviation at each grade of calcification.

In the present study, we have chosen Demirjian's method since it is more simplified and the number of stages are restricted in number to avoid confusion while rating the teeth. Recent studies have reported that Demirjian's method showed the least intra-examiner and inter-examiner errors and a high correlation with biological age. In the present study, mandibular third molars were focused but not the maxillary third molars because of the difficulty in assessing the latter teeth reliably since adjacent structures on the orthopantomographs (e.g. floor or posterior wall of maxillary sinus, zygomatic arch) superimpose the maxillary teeth.

In the present study, Demirjian's Stages A and B were not observed in any of the age groups. The mean age of attainment of Demirjian's Stages C to H is shown in Table 1. The presence of Demirjian's Stage C has not been reported in most of the studies done for the age group of 14-24 years^[1,6,7,8,9] whereas in the present study, Demirjian's Stage C was observed in 14-15 years age groups.

Demirjian's Stages C and D were observed more frequently in the age group of 14-15 years, while Demirjian's Stages E and F were observed in a wide age range of 14-22 years. Demirjian's Stage G was observed in patients above 16 years of age. Demirjian's Stages C, D were not observed in patients above 16 years of age, whereas Demirjian's Stage G was not observed in patients below 16 years of age. Demirjian's Stage H was observed only in patients of 18 years and above. This is in accordance with the studies of Mincer HH et al^[6], Verma P et al^[1], Costa J et al^[11], Lewis AJ et al^[5] for Demirjian's Stage H, showing that the stage H appears in individuals above 18 years of age, and for Stage D which appears

before 18 years of age. In addition to this, in the present study, Demirjian's Stage D was not observed in any patient of age above 16 years.

Overall the mean ages for all Demirjian's Stages for mandibular third molars in the present study are in accordance with the observations made by Johan NA et al^[12], Alshihri AM et al^[9] and Lewis AJ et al^[5] for both males and females and Ajmal M et al^[13] for males. However, the mean ages for Demirjian's stages F and G in both males and females are comparatively more stable than other stages, being in accordance with most of the previous studies.

In the present study, the influence of gender on the development of mandibular third molars (38 and 48) in all Demirjian's Stages expressed slightly earlier development in females than in males. Similar observations were noticed by Verma P et al^[1], whereas these observations are in contrast to Mincer HH et al^[6], who found earlier development in males than females. In the present study, Observer 1 found that for 38 the mean value of female patients was significantly higher than that of male patients for Demirjian's Stage E ($p < 0.01$), (Table 2) and for 48, the mean value of male patients was significantly higher than that of female patients for Demirjian's Stage D ($p < 0.01$) (Table 3), whereas the mean value of female patients was significantly higher than that of male patients for Demirjian's Stage G ($p < 0.05$) (Table 3). Rai B et al^[14] also derived statistically significant differences in third molar development for Demirjian's Stages D and G in males and females in North Indian individuals. Their results indicated that third molar formation was attained earlier in females than in males, as was observed in the present study. Sisman Y et al^[15] also reported statistically significant differences ($p < 0.05$) in third-molar development between males and females regarding the calcification stages D and G. Hamsa R et al^[10] also found

statistically significant difference in mean age between and Stage D.

males and females regarding the calcification of Stage C

Table-2: Age estimation of male and female patients for 38 by Observer 1

Gender	Demirjian's Stages					
	C	D	E	F	G	H
Male	(n=2)	(n=14)	(n=8)	(n=7)	(n=25)	(n=38)
Mean±s.d	14.55±0.62	15.20±0.60	16.25±0.97	16.77±1.20	19.03±1.97	22.47±1.79
Median	14.55	15.11	16.40	17.00	18.60	23.05
Range	14.11-15.00	14.20-16.40	14.50-17.50	14.80-18.10	16.10-18.11	18.11-22.90
Female	(n=5)	(n=17)	(n=11)	(n=14)	(n=34)	(n=45)
Mean±s.d	14.54±0.50	14.78±0.73	18.51±1.85	16.93±2.23	19.50±1.82	22.12±1.81
Median	14.70	14.40	17.85	16.10	19.50	22.50
Range	14.00-15.00	14.10-16.50	16.11-22.00	15.00-21.70	16.11-24.60	18.50-24.80
t-test	0.99	1.72	3.13	0.17	0.94	0.88
p-value	0.36	0.09	0.006*	0.86	0.35	0.38

Table-3: Age estimation of male and female patients for 48 by Observer 1

Gender	Demirjian's Stages					
	C	D	E	F	G	H
Male	(n=1)	(n=16)	(n=6)	(n=8)	(n=23)	(n=40)
Mean±s.d	14.11±0.00	15.14±0.59	16.03±0.83	17.17±1.04	18.61±1.40	22.52±1.79
Median	14.11	15.10	16.25	17.15	18.11	23.05
Range	14.11-14.11	14.20-16.40	14.80-17.00	16.00-19.10	16.10-21.50	18.11-24.80
Female	(n=2)	(n=16)	(n=11)	(n=14)	(n=40)	(n=43)
Mean±s.d	15.05±1.48	14.54±0.39	16.20±1.72	17.71±1.93	19.50±1.63	22.30±1.77
Median	15.05	14.40	16.00	17.20	19.50	22.50
Range	14.00-16.10	14.00-15.20	14.10-20.40	15.00-21.70	16.11-22.80	18.50-24.80
t-test	0.60	3.39	0.22	0.72	2.19	0.56
p-value	0.65	0.002*	0.82	0.47	0.03*	0.57

Previous studies have reported that left-right asymmetry is more common for the third molar than elsewhere in the dentition, but the side difference is random and neither side is systematically advanced.^[6] Similar findings were seen in the present study where it was observed that the initial Demirjian's Stages (C and D) were seen at an

earlier age in 48 as compared to 38, but later Demirjian's Stages (E-H) were seen comparatively at an earlier age in 38 than 48 which suggest that mineralization of crown occurs earlier in 48 but initiation, formation and completion of root occurs comparatively earlier in 38. However this side difference was statistically

insignificant. Therefore, in cases where left-right asymmetry exists, it would be useful to take average of the dental age obtained from both left and right sides.

The comparison of mineralization stages of third molar in males and females in the present study showed that the mean age of attainment of Demirjian's Stages C and D was delayed in males than females which revealed that females were in advancement of dental maturity than males in lower age groups. Similar findings were observed by Gandhi N et al^[16], Mohammed RB et al^[17], Alshihri AM et al^[9]. For Demirjian's Stages E, F and G delay in females than males was observed. This is in accordance with the study done by Gandhi N et al^[16], Solari AC et al^[8], Alshihri AM et al^[9], Johan NA et al^[12]. On the other hand, the mean age of attainment of Demirjian's Stage H was slightly earlier in females than males.(Table 1) However these differences were statistically insignificant. Thus the present study suggests that the mineralization of crown takes place slightly earlier in females than males, but root formation occurs at a faster rate in males than females. The root apex closure occurs slightly earlier in females than males. These observations are in accordance with Verma P et al^[1], Rai B et al^[14], Hassan et al (2007)^[12], Kanmani R et al^[12], Alshihri AM et al^[9], Rani A et al^[18], Gandhi N et al^[16], Humsa R et al^[10].

Thus, according to the present study, in a patient of unknown age if 38 or 48 is observed in Demirjian's Stages A to D, then the possibility of that patient being younger than 16 years is more and if 38 or 48 is observed in Demirjian's Stages E to G, then the possibility of that individual being older than 16 years is more. For medico-legal purposes, 18 years of age is an important cut point. From the present study, it can be said that if 38 or 48 is observed to be in Demirjian's Stages A-D, then it is more likely that the patient is below 18 years of age, whereas if 38 or 48 is in Demirjian's Stage H, then the patient is

more likely to be of 18 years and above. Thus, root maturity (Demirjian's Stage H) in the mandibular third molar can be considered to be a reliable marker that indicates an individual is at least 18 years of age.

Conclusion

The present study concludes that Demirjian's method using mandibular third molar development provides a reliable age range for each Demirjian's Stages for both males and females as well as for both 38 and 48. Since no statistically significant differences were observed in mandibular third molar development between males and female, and left and right side in all Demirjian's Stages of development where both third molars were scorable, both right and left mandibular molars can be used as a reliable indicator for age estimation in males as well as females using Demirjian's method for 14-24 years. Also, it provides a reliable indication of whether an individual is juvenile or adult, i.e., whether he/she is above or below 18 years of age, which is important in medico-legal cases. Thus the results of the present study may be used as a reference for the use of mandibular third molar development for age estimation in adolescents and young adults using Demirjian's method for forensic as well as medico-legal purposes in Aurangabad population.

References

1. Verma P, Sachdeo J, Verma KG, Gupta SD, Guruprasad R. Age Estimation of Adolescents and Young Adults based on Development of Mandibular Third Molars: A Panoramic Study. *J Indian Acad Oral Med Radiol* 2011; 23:9-13.
2. Nur B, Kusgoz A, Bayram M, Celikoglu M, Nur M, Kayipmaz S *et al.* Validity of demirjian and nolla methods for dental age estimation for Northeastern Turkish children aged 5–16 years old. *Med Oral Patol Oral Cir Bucal* 2012; 17:871–7.

3. Aggrawal A. Age estimation in the living - Some Medicolegal Considerations. *Anil Aggrawal's Internet Journal of Forensic Medicine and Toxicology* 2000; 1:1-23.
4. Mahalakshmi V, Kavitha B, Thubashini M. Accuracy of radiographic methods in dental age estimation. *J Forensic Dent Sci* 2011; 3:95-7.
5. Lewis AJ, Boaz K, Nagesh KR, Srikant N, Gupta N, Nandita KP *et al.* Demirjian's method in the estimation of age: A study on human third molars. *J Forensic Dent Sci* 2015; 7:153-7.
6. Mincer HH, Harris EF, Berryman HE. The A.B.F.O. study of third molar development and its use as an estimator of chronological age. *J Forensic Sci* 1993; 38:379-90.
7. Darji JA, Govekar G, Kalele SD, Hariyani H. Age Estimation from Third Molar Development-A Radiological Study. *J Indian Acad Forensic Med* 2011; 33:130-4.
8. Solari AC, Abramovitch K. The accuracy and precision of third molar development as an indicator of chronological age in Hispanics. *J Forensic Sci* 2002; 47:531-5.
9. Alshihri AM, Kruger E, Tennant M. Western Saudi adolescent age estimation utilising third molar development. *Eur J Dent* 2014; 8:296-301.
10. Hamsa R, Thilaga R, Hameed A, Anu Priya S, Arun Priya S, Gupta N. Age Estimation Using Mandibular Third Molars. *Indian Journal of Dental Sciences* 2014; 6:8-10.
11. Costa J, Monterob J, Serranob S, Albaladejob A, López-Valverde A, Bicaa I. Accuracy in the legal age estimation according to the third molars mineralization among Mexicans and Columbians. *Aten Primaria*. 2014; 46:165-75.
12. Johan NA, Khamis MF, Jamal NSA, Ahmad B, Mahanani ES. Variability of lower third molar development in Malaysia for age estimation. *Journal of Forensic Odontostomatol* 2012; 30:45-54.
13. Ajmal M, Assiri KI, Al-Ameer KY, Assiri AM, and Luqman M. Age estimation using third molar teeth: A study on southern Saudi population. *J Forensic Dent Sci*. 2012; 4:63-5.
14. 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; 27:45-9.
15. Sisman Y, Uysalb T, Yagmurc F; Ramoglu SI. Third-Molar Development in Relation to Chronologic Age in Turkish Children and Young Adults. *Angle Orthodontist* 2007; 77:1040-5.
16. Gandhi N, Jain S, Kumar M, Rupakar P, Choyal K, Prajapati S. Reliability of Third Molar Development for Age Estimation in Gujarati Population: A Comparative Study. *J Forensic* 2015; 7:1-6.
17. 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; 6:191-6.
18. Rani A, Khanna SK, Mittal AK, Grewal H, Behera C. Age Estimation by Clinico-Radiological Examination of Third Molar Teeth: A Study from Delhi. *J Indian Acad Forensic Med*. October-D
19. ebruary 2014; 36:349-54.