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Review Article

Role of Dentists in Dental Age Assessment: Legal Provisions in India & Limitations

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ABSTRACT

Article 6 of the Universal Declaration of Human Rights states, "that everyone has the right to recognition everywhere as a person before law". Therefore, every citizen of a member State of the United Nations has a right to possess his personal identity. Age is one of the key parameters to establish identity of an individual. For age estimation, among the various parameters, dental examination also provides useful information. Hence, dental age assessment (DAA) is an important task for all dentists to perform and more so after the recent amendments in the provisions related to age assessment under Juvenile Justice (Care and Protection of Children) Act (JJA) in this country (India). However, like other parameters, DAA has its limitations. This issue has been examined in light of the various court judgments on of this aspect of practice of forensic dentistry after reviewing majority of the methods used for DAA available in the literature and recommendations have been made for appropriate methods that can be used in different age groups and scenario.

Keywords: Identity, Dental age assessment, Forensic dentistry, Limitations, Legal provisions

INTRODUCTION

Identity is defined as the recognition of individuality of a person, live or dead[1]. Article 6 of the Universal Declaration of Human Rights states," that everyone has the right to recognition everywhere as a person before law". Therefore, every citizen of a member State of the United Nations has a right to possess his personal identity, unquestioned[2]. The process of identification is usually based upon the observation of physical appearance/ morphology. This simple procedure at time can be rather tedious and demanding in special circumstances like: mass disaster; dismembered body; extreme putrefaction and fossilization etc. Forensic Identification by their nature are multidisciplinary team efforts that typically involve co-ordination and co-operation of law enforcement officials, forensic pathologists, forensic odontologists, forensic anthropologists, serologists, criminalistics and other specialists deemed necessary[3].

There are numerous criteria that can be employed for person identification, such as: Race and Religion, Age, Sex, Teeth, Stature, Fingerprints and other biological prints, External peculiarities, Hair, Personal effects, Handwriting, Speech and voice, Gait etc[4]. The dentists can play a key role in person identification both in living and dead in numerous ways like:

1. Estimation of age from dentition/ Dental Age Assessment (DAA);
2. Estimation of sex from dentition and skull examination;
3. Bite mark comparison;

4. Individualization based on cheiloscopy and Rugae prints;
5. Individualization based upon special characters of teeth/dentition; and
6. Denture identification and dental records.

Legal Provisions and Dental Age Assessment (DAA)

There are numerous laws that require assessment of age, the prominent being, Juvenile Justice (Care and Protection of Children) Act, 2000 (JJA), Immoral Traffic Prevention Act, 1950 (ITPA) and Different Sections of Indian Penal Code, Evidence Act etc.

Regarding age estimation legal provisions has been made under the JJA. As per the law, the procedure of inquiry for age of a juvenile is to be conducted as per Section 7 of JJA read with Rule 12 (3) of the Juvenile Justice (care and Protection of Children) Rules, 2007, enumerated below:

Procedure to be followed in determination of Age-

(1) In every case concerning a child or a juvenile in conflict with law, the Court or the Board or as the case may be the Committee referred to in Rule 19 of these rules shall determine the age of such juvenile or child or a juvenile in conflict with law within a period of thirty days from the date of making of the application for that purpose.

(2) The Court or the Board or, as the case may be the Committee shall decide the juvenility or otherwise of the juvenile or the child or as the case may be the juvenile in conflict with law, prima facie on the basis of physical appearance or documents, if available, and send him to the observation home or in jail.

(3) In every case concerning a child or juvenile in conflict with law, the age determination inquiry shall be conducted by the Court or the Board or, as the case may be, the Committee by seeking evidence by obtaining-

(a) (i) the matriculation or equivalent certificates, if available, and in the absence whereof;

(ii) the date of birth certificate from the school (other than a play school) first attended; and in the absence whereof;

(iii) the birth certificate given by a corporation or a municipal authority or a Panchayat;

(b) and only in the absence of either (i), (ii) or (iii) of Clause (a) above, the medical opinion will be sought from a duly constituted Medical Board, which will declare the age of the juvenile or child. In case exact assessment of the age cannot be done, the Court or the Board or, as the case may be, the Committee, for the reasons to be recorded by them, may, if considered necessary, give benefit to the child or juvenile by considering his/her age on lower side within the margin of one year.

And, while passing orders in such case shall, after taking into consideration such evidence as may be available or the medical opinion, as the case may be, record a finding in respect of his age and either of the evidence specified in any of the Clauses (a) (i), (ii), (iii) or in the absence whereof, Clause (b) shall be the conclusive proof of the age as regards such child or the juvenile in conflict with law[5].

The rule state that medical opinion should be obtained from a duly constituted medical board (Not individual). But, they are silent on the issue that who all will be the members of the board, who will constitute the board and where it will function? To decide these issues, however, there are some judicial pronouncements. Relevant gist of these judgments is reproduced below:

1. In case of Court on its Own Motion V/S Dept. of Women and Child Development and others, WP (C) No. 8889/2011, High Court of Delhi[6].

   The court delivered its judgment on 11/05/2011 and directed as per point L- For the Govt. Hospital & Medical Board:

(i) All Govt. hospitals shall constitute medical boards to carry out medical age examination and shall give report not later than 15 days of request being made in this regard.

(ii) All the members of medical board (Physiologist, Dental Examiner and Radiologist/ Forensic expert) shall give their individual reports based on their respective examinations and the same shall be mentioned in report, based upon which the

chairperson shall give the final opinion on the age with in a margin of one year.

2. In case of Mor Pal V/S State of Delhi. Crl MC 3962/ 2012, High Court of Delhi[7].

The court delivered its judgment on 25/02/2013. As per point 17 of the said judgment, the duly constituted medical board of the Govt. hospital should comprise of a minimum of a dentist, a general physician and one radiologist.

Both the judicial pronouncements cited above on the constitution of the medical board for age estimation clarifies that:

a) These board are to formed in Govt. establishments only;

b) There should be minimum of 3 members, more could be co-opted (depending upon need);

c) A dentist is a common member in both judgments; and

d) Report in such cases to be submitted with in 15 days of receiving the request in this regard.

Forensic Age Assessment

Forensic age assessment is affected by the unavoidable limits concerning difficulties in standardization of methods and procedure. The literature has shown several methods of age estimation, and though they may be thought of as equivalent, every procedure has its limits, mean error, practical situation and age range where it gives the best result. The lack of standardization and consensus concerning which method can be used, as well as the lack of practical approach in different cases is the main limit in a correct age assessment process[8].

The 3 step examination for clinical age assessment performed routinely consists of:

a) General and physical examination;

b) Dental examination; and

c) Radiological examination.

The discussion on General and Physical & Radiological Examination is not avoided here as in this paper authors are inclined to discuss DAA mainly.

Dental Examination

Literature on dental age estimation provides broad and extensive information about various methods, their technical implementation, and underlying mechanisms. Dental age can be assessed according to developmental traits such as mineralization, gingival emergence, the quantification of cementum layers or the narrowing of the pulpal space. Degenerative changes such as dental attrition, or periodontal recession also show a correlation with chronological age. A variety of parameters such as the fluorescence intensity and density of dentin, the racemization of aspartic acid or dentin sclerosis help to evaluate the age-related conversion of dental tissues can also be used in human age estimation.

Chronology/Development of Teeth

Tooth formation is a complex process that begins with a gradual reorganization and a shift in the phenotype of embryonic cells. Deciduous teeth start to develop in the 6^{th} to 8^{th} gestational week; permanent teeth in about the 20^{th} week of gestation. In age estimation the term "tooth formation" usually refers to the mineralization of dental hard tissues and does not necessarily consider unmineralized formation stages of the tooth germ. A reason for this may be that mineralized tissue can be easily evaluated via radiographic methods and remains after death and decomposition of the organism. Data on the timing of human dental development is based on morphological, histological & radiological studies.

There are controversies as to the precision about tooth development and its applicability to assess chronological age, however, most reports suggest that there is a moderately good correlation. The first major attempt at developing chronology for human tooth development was that of Logan and Kronfeld[9] that is still usable with minor modification as a rough and ready guide.

The tables of Schour and Massler[10] have become a classic example of the frequently used atlas approach. Observations on whole jaw sections made by Logan and Kronfeld enabled the them to prepare diagrams which are each associated with a particular age. This atlas-based system does not evaluate root formation stages but deals with the sequence and timing of emergence of tooth crowns in the oral cavity. Schour and Massler's data

represent 22 stages of dental development starting from 5 months in utero until 35 years of age.

Numerous studies have shown that chronology of teeth eruption both temporary and permanent is orderly, sequential and age specific[11]. However on the other hand, enough literature exists to describe the variations and the reasons for such variations in eruption timings[12]. The Tables 1 & 2 describes different studies regarding mean/ median eruption timings along with standard deviation.

3rd Molar Tooth

As per the JJA, 2000, a person who has not attained the age of 18 years is considered juvenile. Hence, assessment of 18 years age has become quite crucial as far as Indian law is concerned. The eruption of tooth at this age is almost complete except the 3rd Molar. In late adolescents and emerging adults the 3rd permanent molar may be the only remaining tooth to have not yet reached maturity[18]. The maturity of the 3rd permanent molar could be suitable mean for estimating age in subjects of unknown birth date for emerging adults. The staging of 3rd molar crown and root mineralization can be accomplished easily and non-invasively through evaluation of dental radiographs. Several staging systems have been developed to describe the dental maturation process. Because of relatively frequent absence of one or more of the 3rd molar, it is appropriate to have data for each of the 3rd molar[19]. The Mincer method[20] is commonly employed for dental age assessment during this phase of age. Mincer in his lead paper describes that average difference between chronological and that predicted from molar formation was about 1.6 years (S D=1.2). This translates to a span of about 4.8 years to encompass the 95% confidence limit. The study on Hispanics between the age of 14.0 years to 25.0 years shows the mean absolute difference between chronological age and estimated age as +/_ 3.0 years in females and +/_ 2.6 years in males[18].

Table 1: Eruption time of Primary Teeth in months

Teeth No. (ISO 3950)[13]	Study 1[14] (For Boys only)		Study 2[15]	
	Mean	SD	Mean	SD
51	11.9	0.7	11.1	2.9
52	13.3	0.9	13.1	4.0
53	21.0	1.3	19.0	7.2
54	17.3	1.0	15.3	3.6
55	29.3	1.0	25.7	4.3
61	12.0	0.8	-	-
62	13.4	1.0	-	-
63	21.1	1.3	-	-
64	17.5	1.1	-	-
65	19.5	1.4	-	-
71	10.5	0.4	-	-
72	12.7	0.8	-	-
73	21.9	1.1	-	-
74	19.1	0.8	-	-
75	27.2	0.8	-	-
81	10.9	0.7	10.0	1.4
82	12.6	0.9	12.7	1.0
83	22.2	1.4	21.4	4.1
84	19.0	0.8	15.2	4.3
85	26.8	1.8	25.6	7.4

In a prospective study performed on 47 judicial cases involving illegal migration, where age of 18 years was crucial to decide in order to send the accused either in juvenile home of jail, all skeletal and dental method gave borderline results. An examination of the motivations of the final sentences showed that when the Mincer method was applied, giving the probability of the individual having reached the age of 18 years, the judges expressed appreciation for the fact that in this way, the risk taking was easier to comprehend. Interestingly, it was seen that when the probability of the individual of being 18 or over was 70%, the judges felt confident in taking the risk of an “adult” verdict[21].

Olze attempted to assess the age of 21 years by examining mineralization of 3rd molars using orthopentogram morphologically, concluded that classification whether the age is <, =, or > than 21 years was 69.7% correct in males and 71.4% in females[22].

Demerjian Method

Demerjian[23] classified the development of teeth by radiological staging to estimate age of a person. The original method used only the seven mandibular teeth (except 3rd molar) on the left side and assigned a gender specific maturity score to each tooth. The teeth are

Table 2: Eruption time of Secondary/ Permanent Teeth in years

Teeth Number (ISO 3950)[13]	Study 1[16] (For both Boys and Girls combined)		Study 2[11] (Median for Boys only)	Study 3[17] (For boys only)	
	Mean	SD		Mean	SD
11	6.2	1.5	6.8	7.5	1.2
12	7.4	1.2	8.0	8.7	1.2
13	10.4	1.4	9.9	11.7	1.2
14	9.4	1.2	9.7	10.8	1.3
15	9.8	1.2	10.6	11.5	1.3
16	5.4	0.9	5.6	5.4	1.2
17	10.6	1.2	11.6	12.6	1.1
21	6.2	0.8	7.1	7.3	0.7
22	7.8	1.3	7.8	8.7	1.1
23	10.0	1.3	9.9	11.7	1.2
24	9.4	1.3	9.7	10.8	1.4
25	9.8	1.5	10.6	11.5	1.3
26	6.3	1.8	5.7	5.4	1.0
27	11.1	2.0	11.6	12.7	1.0
31	5.7	2.1	6.2	6.8	0.9
32	6.1	0.7	7.2	7.9	1.0
33	10.0	2.0	9.7	11.4	1.3
34	9.4	1.3	9.8	10.9	1.4
35	10.4	1.1	10.8	11.3	1.3
36	5.5	0.8	5.7	5.1	1.2
37	6.2	1.5	11.3	12.2	1.2
41	7.4	1.2	6.0	6.9	0.9
42	10.4	1.4	7.3	7.9	1.1
43	9.4	1.2	9.7	11.4	1.3
44	9.8	1.2	10.0	10.9	1.4
45	5.4	0.9	10.8	10.9	1.3
46	10.6	1.2	5.6	5.0	1.4
47	6.2	1.2	11.3	12.3	1.1

observed using panoramic radiograph and classified by means of an 8 stage system (ranging A to H; an additional stage O, which represent no sign of calcification). The score were summed up and compared with centile charts to arrive at the age.

Numerous studies were conducted around the globe to measure the applicability of Demerjian method on various populations like Indian[24-26], Chinese[27], Turkish[28], Caucasian American[29], Dutch[30], Brazilian[31], Australian[32] and British[33].

According to a recent meta-analysis on 26 studies related to Demerjian method with sample size of 11,499 children (5301 boys and 6198 girls), it was concluded that this method tends to estimate dental age as more advanced than chronological age. The over-estimation of dental age varied between 0.78 to 1.97 years for boys (mean 0.35

years) and 0.86 to 1.31 years for girls (mean 0.39 years). This over-estimation varies from 0.28 to 0.38 yrs amongst Asian and Caucasian boys and 0.24 to 0.52 yrs amongst same racial girls[34].

When Sarkar[35] compared Demerjian 8 teeth formula with India specific Demirjian formula proposed by Acharya[36], found that the Demerjian formula underestimated the mean dental age by 1.63 years in males and 1,54 years in females, whereas, with Acharya's formula variation was 0.10 years in males and 0.94 years in females.

Cameriere, Haavikko & Willems Method

Cameriere introduced a concept of estimation of chronological age in children by measuring the open apices in seven mandibular teeth on radiographs of Italian children, as well as on pulp/ tooth ratio[37]. Haavikko suggested adopting an age estimation method based on determination of one of 12 radiographic stages of four permanent teeth; different teeth were used for children under and after 10 years of age. Method was based on previous radiographic evaluation of all permanent teeth on 885 Finnish children ages 2 to 13 years and is useful when some permanent teeth are missing[38].

Willem's Method: Each tooth on the left side of mandible (except the third molar) is given a letter from A to H depending upon its developmental criteria. Each letter corresponds to a score. Maturity scores were converted into fractions of dental age using published conversion tables then these were summed to obtain dental age. Different standards are used for boys and girls[39].

When the above and few other radiological methods were assessed for accuracy by different researchers it was found that method of Willems was the most accurate. Haavikko method yielded a mean estimation of 0.04 years for boys and 0.03 years for girls was significantly different ($p<0.01$). The Cameriere method yielded a mean estimation of 0.05 for boys or 0.04 years for girls; accuracy between boys and girls was significantly different ($p<0.01$), Nolla method yielded mean estimation of 0.07 for boys and 0.08 for girls, significantly different from chronological age ($p<0.01$). Demirjian method was least accurate method[40].

In a yet another study to evaluate applicability of Demirjian and Willems methods for calculating dental age of children in the Former Yugoslav Republic of Macedonia were analyzed using panoramic radiographs of 966 children (485 female and 481 male, aged 6-13 years) by four Demirjian methods and a Willems method for determining dental ages. Intra-rater and inter-rater agreement of mineralization stages were 0.86 and 0.82, respectively. All methods significantly overestimated dental age when compared to the chronological age ($p<0.001$). The greatest overestimation was for method from 1973 using 7 teeth (1.17±0.98 years).Thus, concluding that Willems method was the most accurate while Demirjian's methods for dental age calculation were stated as unsuitable[41].

Lamendin Method

A method for age determination of adults from single rooted teeth is presented. It is based on the measurement of two dental features: periodontosis height times 100/ root height (P) and transparency of the root height times 100/root height (T). These measurements are made on the labial surface of the entire tooth without section and do not require special equipment or training. The application of multiple regression analysis to a working sample of 306 teeth of known age, sex and race provided the following equation: Age (years) = 0.18 x P + 0.42 x T + 25.53. The mean error between the actual and estimated age was +/- 10 years on the working sample and +/- 8.4 years on a control sample made of 45 forensic science cases. Upper incisors showed a better precision than the other single rooted teeth and accuracy was not sex related. The Lamendin method can be practical interest for any forensic pathologist or dentist as it is fast, easy to use, and reasonably accurate except for cases of individuals under age 40 where other methods must be preferred[42].

Aspartic Acid Racemization & Carbon Dating

During the course of aging, L-forms of amino acids are transformed by racemization to the D-forms. At a temperature of _25°C, it would take _100,000 years for all L-forms of amino acids present in living tissues to undergo complete racemization to the D-amino acid form[43]. Thus, the extent of racemization of amino acids may be used to estimate the age of various tissues. Of all

stable amino acids, aspartic acid has one of the fastest racemization rates and is therefore the amino acid most commonly used for age estimation. Rates of change of L-form amino acids to D-forms are influenced by various factors, such as temperature, humidity, pH, etc[44]. Radiocarbon analysis showed an excellent precision with an overall absolute error of 1.0 +/_0.6 years. Aspartic acid racemization also showed a good precision with an overall absolute error of 5.4+/_ 4.2 years. Whereas radiocarbon analysis gives an estimated year of birth, racemization analysis indicates the chronological age of the individual at the time of death[45].

Pulp Chamber Based Method

One of the relatively newer methods of dental age assessment is apposition of secondary dentine which represents an ongoing, regular process. The mean rate of increasing dentinal thickness due to deposit layers of secondary dentine has been found to be 6.5 l m per year for the crown and 10. l m per year for the root. The effect of continuous dentine deposition is the progressive increase in dentinal thickness by 0.45 mm (17.1%) and0.60 mm (24.3%) in the crown and root areas, respectively. The pattern of secondary dentine deposition varies with tooth type. In 1925, Bodecker ascertained that the apposition of secondary dentine was correlated to chronological age. Secondary dentine deposition was included in the method pioneered by Gustafson, in which dentine transparency and secondary dentine values showed the highest correlation with age. Secondary dentine has been studied by several methods: examples are sectioning and X-rays. Kvaal[46] and Paewinsky obtained reproducible measurements of the dental pulp chamber and great correlation between the individual age and the dimensions of the pulp chambers. Currently, the apposition of secondary dentine by peri-apical X-ray may provide a useful tool in age estimation in adults. Depending on the available number of premolar teeth, the mean of the absolute values of residual standard error, at 95% conûdence interval, ranged between 4.34 and 6.02 years, showing that the pulp/ tooth ratio is a useful variable for assessing age with reasonable accuracy[37].

The conventional radiographs suffers from the disadvantage that they are two-dimensional projections, which are subject to considerable magnification and distortional errors. Therefore, a simultaneous assessment of the mesio-distal and bucco-lingual dimensions of teeth has been recommended. Computed tomography (CT) is claimed as an ideal and most accurate method to evaluate the pulp/tooth volume ratio[47]. A recent study assessed the suitability of pulp/tooth volume ratio of mandibular canines for age prediction in an Indian population. Volumetric reconstruction of scanned images of mandibular canines from 140 individuals (aged ten - 70 years), using computed tomography was used to measure pulp and tooth volumes. The regression equation obtained for the Indian population: Age = 57.18 + (- 413.41 x pulp/ tooth volume ratio), was applied to an independent control group (n = 48), and this resulted in mean absolute errors of 8.54 years which was significantly ($p < 0.05$) lower than those derived with the Belgian formula[48].

Indian Courts & Dental Evidence

The opinion of the Indian Court on the assessment of age is variable, e.g. in a judgment about century ago, in case of Mohd Syedol Arrifin V/S Yeoh reported in All India Reporter 1916, the court opined that, “the opinion of the doctor was formed by judging the teeth, appearance and voice, and a certificate based on this is worthless”[49]. However, recent court judgments have shown that court have started relying more and more upon the medical opinion based commonly on the ossification test[50,51].

REFERENCES

[1] Rao NG. Textbook of Forensic Medicine & Toxicology. 2nd ed., N-Delhi, Jaypee Brothers Med Pub (P) Ltd 2010;p-65.

[2] General Assembly Resolution, 217-A (III), 3rd Session Suppll No 13, dt 10.12.1948;p-71-7.

[3] Fixot RH, Arendt D, Chez B, Mcgivney J, Wanick A. Role of dental teams in mass fatality incidents. Dent Clin North Am 2001;45: 271-92.

[4] Biswas G. Review of Forensic Medicine & Toxicology. 2nd ed. N-Delhi, Jaypee Brothers Med Pub (P) Ltd 2012;p-45.

[5] Juvenile Justice (Protection and Care of Children) Act, 2000 and Juvenile Justice (Protection and Care of Children) Rules, 2007.

[6] Court on its Own Motion V/S Dept. of Women and Child Development & others. WP (c) No 8889/2011, High Court of Delhi.

[7] Mor Pal V/S State of Delhi. Crl MC 3962/2012, High Court of Delhi.

[8] Cuhna E, Baccino E, Martrille L, Ramsthaler F, Prieto J, Schuliar Y *et al.* The problem of aging human remains and living individuals: A review. Forensic Sci Int 2009; 193:1-13.

[9] Logan WHG, Kronfield R. Development of human jaws and surrounding structures from birth to the age of fifteen years. JADA 1933; 20:379-427.

[10] Schour I, Massler M. The development of human dentition. JADA 1941;28;1153-60.

[11] Agarwal KN, Gupta R, Faridi MMA, Kalra N. Permanent dentition in Delhi boys of age 5-14. Indian Pediatr 2004; 41: 1031-35.

[12] Oziegbe EO, Adekoya-Sofowora C, Folayan MO, Esan TA, Owotade FJ. Relationship between socio-demographic and anthropometric variables and number of erupted primary teeth in suburban Nigerian children. Matern Child Nutr 2009; 5: 86-92.

[13] www.iso.org.iso/iso_catalogue_detail.htm

[14] Guna Shekhar M, Tenny J. Longitudinal study of age and order of eruption of primary teeth in Indian children. J Clin Exp Dent 2010;2: e113-6.

[15] Gupta A, Hiremath SS, Singh SK, Poudyal S, Niraula SR, Baral DD, Singh RK. Emergence of Primary Teeth in Children of Susari District of Eastern Nepal. MJM 2007;10: 11-19.

[16] Kutesa A, Nkamba EM, Muwazi L, Buwembo W, Rwenyonyi CM. Weight, height and eruption times of permanent teeth of children aged 4-15 years in Kampala, Uganda. BMC Oral Health 2013;13:15.

[17] Lakshmappa A, Guladgud MV, Patil K. Eruption times and patterns of permanent teeth in scholl children in India. Ind J Dent Res 2011;22: 755-63.

[18] Solari A, Abramovitch K. The accuracy and precision of third molar development as an indictor of chronological age in Hispanics. J Forensic Sci 2002;47: 531-35.

[19] Nambiar P. Age estimation using 3rd molar development. Malaysian J Pathol 1995; 17:31-34.

[20] Mincer HH, Harris EF, Berryman HE. The ABFO study of third molar development and its use as an estimator of chronological age. J Forensic Sci 1993; 38: 379-90.

[21] Grillo BP, Cattaneo C, Panigalli C, Grandi M. Can a combined hand –wrist method increase accuracy of age estimation of offenders who claims to be under 18 years of age? In: 16th Meeting of the International Association of Forensic Sciences. Proceedings, Montpellier, France, 2-7 September,2002.

[22] Olze A, Mahlow A, Schmidt S, Wernecke KD, Geserick G, Schmeling A. Combined determination of selected radiological and morphological variables relevant for dental age estimation of young adults. Homo 2005; 56: 133-40.

[23] Dermijian A, Goldstein H, Tanner JM. A new system of dental age assessment. Hum Bio 1973; 45; 211-27.

[24] Koshy S, Tandon S. Dental age assessment: applicability of Demirjian method in South Indian children. Forensic Sci Int 1998; 94: 73-85.

[25] Grovers S, Marya CM, Avinash J, Pruthi N. Estimation of dental age and its comparison with chronological age: accuracy of two radiographic methods. Med Sci Law 2012; 52: 32-35.

[26] Malik P, Saha R, Agarwal A. Applicability of Demerjian method of age assessment in North Indian female population. Eur J Paediatr Dent 2012; 13: 133-35.

[27] Jayaraman J, King NM, Roberts GJ, Wong HM. Dental age assessment: are Demerjian's standards appropriate for southern Chinese children? J Forensic Odontostmatol 2011; 29; 22-28.

[28] Kirzioglu Z, Ceyhan D. Accuracy of different dental age estimation methods on Turkish children. Forensic Sci Int 2012; 216: 61-67.

[29] Weddell LS, Hartsfield JK Jr. Dental maturity of Caucasian children in the Indianpolis area. Pediatr Dent 2011; 33: 221-27.

[30] Leurs IH, Wattel E, Aartman IH, Etty E, Prahl-Andersen B. Dental age in Dutch children. Eur J Orthod 2005; 27: 309-14.

[31] Maia MC, Martins Mda G, Germano FA, Brandao Neto J, Da Silva CA. Demerjian's system for estimating the dental age of nerthestern Brazilian children. Forensic Sci Int 2010; 200: e171-74.

[32] Flood SJ, Mitchell WJ, Oxnard CE, Turlach BA, McGreachi J. A comparison of Demerjian's four dental development methods for forensic age assessment. J Forensic Sci 2011; 56: 1610-15.

[33] Yadava M, Roberts GJ, Lucas VS. Dental age assessment (DDA): reference data for British children at the 10 years old threshold. Int J Legal Med 2011; 125: 651-57.

[34] Yan J, Lou X, Xie L, Yu D, Shen G, Wang Y. Assessment of Dental age of Children aged 3.5 to 16.9 years using Demirjian Method: A Meta-analysis based on 26 studies. PLOS 2013; 8: e84672

[35] Sarkar S, Kailasam S, Mahes Kumar P. Accuracy of estimation of dental age in comparison with chronological age in Indian population- a comparative analysis of two formula. J Forensic Leg Med 2013; 20: 230-33.

[36] Acharya AB. Age estimation in Indian using Demerjian's 8 teeth method. J Forensic Sci 2011;56: 124-27.

[37] Cameriere R, Luca SD, Aleman I, Ferrante L, Cingolani M. Age estimation by pulp/tooth area ratio in lower premolars by orthopantomography. Forensic Sci Int 2012; 214: 105-12.

[38] Haavikko K. The formation and the alveolar and clinical eruption of the permanent teeth: An orthopanthomographic study. Proc Finn Dent Soc 1970; 66: 103-70.

[39] Willems G, Van Olmen A, Spiessens B, Carels C. Dental age estimation in Belgian children: Demirjian's technique revisited. J Forensic Sci 2001;46: 893-95.

[40] Rai B, Anand SC. Tooth development: an accuracy of age estimation of radiographic methods. World J Med Sci 2006;1: 130-32.

[41] Ambarkova V, Galiæ I, Vodanoviæ M, Bioèina-Lukenda D, Brkiæ H. Dental age estimation using Demirjian and Willems methods: cross sectional study on children from the Former Yugoslav Republic of Macedonia. Forensic Sci Int 2014; 234:187.

[42] Lamendin H, Baccino E, Humbert JF, Tavernier JC, Nossintchouk RM, Zerilli A. A simple technique for age estimation in Adult corpses: the two criteria dental method. J Forensic Sci 1992; 37:1373-79.

[43] Helfman, PM., Bada, J L. Aspartic acid racemisation in dentine as a measure of ageing. Nature 1976; 262: 279–281.

[44] Yekkala R, Meers C, Schpdael V, Hoogmartens J, Lambrichts I, Willems G. Racemization of aspartic acid from human dentin in estimation of chronological age. Forensic Sci Int 2006; 159:589-94.

[45] Alkass K, Buchholz BA, Ohtani S, Yamamoto T, Druid H, Spalding KL. Age Estimation in Forensic Science-Application of combined Aspartic acid racemization and Radiocarbon analysis. Mol Cell Proteomics 2010; 9: 1022-30.

[46] Kvaal SI, Kolltviet KM, Thomsen IO, Solheim T. Age estimation of adults from dental radiographs. Forensic Sci Int 1995; 74: 175-85.

[47] Yang F, Jacobs R, Willems G. Dental age estimation through volume matching of teeth imaged by cone-beam CT. Forensic Sci Int 2006;159:S78-83.

[48] Jagannathan N, Neelakanthan P, Thiruvengadam C, Ramani P, Prem Kumar P, Natesan A *et al*. Age estimation in an Indian population using Pulp/ Tooth volume ratio of mandibular canine obtained from cone beam computed tomography. J Forensic Odotostomatol 2011; 29:1-6.

[49] Mohd Syedol v/s Yeoh AIR 1916 PC 242.

[50] Suchitra Srivastava v/s Chandigarh Administration, (2009) 9 SCC 1.

[51] Paramjit v/s State of Himachal Pradesh (1987) Cr LJ 1266.