Forensic dental age estimation using Third Molar’s: A review

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Abstract

The word ‘Forensic’ is derived from the Latin word ‘Forensis’ meaning public. In modern times it has wide applications for age estimation in civilian and criminal purposes both in the deceased and live cases. Chronological age (CA) is duration of one’s life after birth. Forensic dental age (DA) is radiographic estimated age minus chronological age. Chronological age is independent factor and dental development is dependant factor. Forensic dental age estimation can be assessed by numerous techniques like demirjian’s, kohler’s, kullmun’s method. Demirjian’s technique is the most commonly used worldwide.

Keywords: CA (chronological age), DA (dental age).

Introduction

The method of Moorrees, Fanning and Hunt (1983) was used extensively for dental age estimation until Demirjian, Goldstein and Tanner (1973) published their new dental age estimation method. The MFH method predicted the stage of development of the teeth at a certain age whereas the DGT method was originally regarded as a better method of dental age estimation. Several authors have however shown that the use of DGT method was not accurate when applied to their population sample [1-5]. The demirjian method was first applied to French Canadian population in 1973 [6]. The Demirjian and Goldstein used 7 left mandibular teeth excluding the wisdom tooth due to variations in its development, eruption and anatomy. The original demirjian’s method is not feasible after 16 years of age, which coincides with the completion of root development of second molar [7]. Dental age may be assessed either by tooth eruption dates or by the progress of tooth calcification. The latter is a continuous process which progressively calcify in several easily definable stages and stage of calcification is least susceptible to environmental changes and is independent of somatic growth. Tooth emergence is an fleeting event which is for short duration and is difficult to assess and can be altered by lack of space or nutritional status [8, 9]. The dental age can be determined by: clinical emergence of teeth represents only one stage represents only one stage in the continuous process of dental eruption. Visible emergence usually occurs when root formation is about three quarters completed, moreover this method can only be used for short periods since between the ages of 2.5 – 6 years, 8 – 10 years and 13 – 18 years no teeth will emerge. [10, 11] The word ‘Forensic’ is derived from the Latin word ‘Forensis’
meaning public [12]. Its applicable in Civil cases like identification in mass disasters, employment and retirement, Marriage, Management of property, Voting right, Competency as witness, insurance claims, passport, visa. In criminal cases like rape, criminal abortion, infanticide, murder, juvenile offenders and criminal responsibilities identification is essential. In cases in which dead body of a person claimed to be that of a missing person, cases of unnatural death of unidentified bodies due to suspected foul play [13].

**Medico Legal Importance of Age**

Criminal responsibility [14] – Any act that is done by a child under the age of 7 years is not an offence. A child between 7 and 12 years is presumed to be incapable of committing an offence (Sec.82, IPC). Judicial Punishment [14] – According to Section 2 (k) of The Juvenile Justice (Care and Protection of Children), Act 2000, a “juvenile” or “child” means a person who has not completed 18 years of age. A child (Under Children's Act 1960) is sent to Children's home on commission of an offence, but is not retained there beyond the age of 18 years. Marriage contract [14] – The minimum legal age for marriage in India is 21 years for boys and 18 years for girls. Child Marriage Restraint Act, 1978). Employment [14] – According to Article 24 of The Indian Constitution, a child below 14 years shall not be employed to work in any factory or mine or engaged in other hazardous employment (same provisions are reproduced in Section 67 of The Indian Factories Act 1948). Rape [14] – Under section 375 of the I.P.C. (local amendment by Manipur Government), sexual intercourse with or without consent is rape if the age of the woman is less than 14 years (This provision is for the state of Manipur only by a local amendment. For the rest of the country this age is 16 years). According to Section 375 of I.P.C, sexual intercourse with one's own wife, even with her consent, is rape if she was below 15 years (By a local amendment this age has been reduced to 13 years for the state of Manipur).

Kidnapping [14] – According to Section 369 of I.P.C., to constitute a crime of kidnapping or abducting a child with the intention of taking dishonestly any moveable property from its person, the age of such child should be below 10 years. For the purposes of this section a minor is a male below the age of 16 years, and a female below 18 years. Attainment of majority [14] – According to Indian Majority Act 1875, a person attains majority when he/she attains the age of 18 years. When a minor is under the guardianship of the Court of Wards, or is under a guardian appointed by the Court, he is not deemed to attain majority until he is 21 years of age.

Estimating age from teeth is generally reliable as they are naturally preserved long after all the tissues and even bones have disintegrated, [15-18] but unlike bone they can also be inspected directly in living individuals [17, 18]. The high resistance of the teeth to severe insults such as cold, heat, fire and chemicals makes them favorite tissue in forensic and archaeological investigations [15]. Teeth, which provide the life history of an individual, contribute as a reliable means of determining age from approximately 10 weeks of intrauterine life up to old age [15]. The analysis of carpus ossification nuclei a method commonly used for clinical-diagnostic purposes, among others, is well-grounded and internationally accepted when juveniles of about 14 are involved [19], but when dealing with subjects of around 18, the method is no longer valid because skeletal
maturity virtually nullifies any detectable modification and no assessment can be made correctly [20]. Age assessment in young children is more precise as multiple teeth are in their various stage 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 characteristic have already been taken place by middle teens and early twenties. Third molar become most useful when there is a need to determine the juvenile or adult status of an individual when no valid document with the recorded age is available [15].

Chronology of Mandibular Third Molar- first evidence of calcification 8 to 10 years, enamel completed 12 to 16 years, eruption 17 to 21 years, root completed 18 to 25 years [21]

Demirjian’s 8 teeth Method the seven left mandibular teeth were rated on an 8-stage scale from A to H according to Demirjian’s method revisited. Moreover, for more accuracy the stage 0 (bone crypt is visible without dental germ inside it) and the stage 1 (crypt stage) were added making ten stages. For easy computation alphabetical A – H is replaced with 0 to 9 for each tooth. The sum of the score for each tooth is a dental maturity score rescaled linearly to 100. This score is converted in dental age using appropriate tables of 5th percentiles. The Demirjian’s 7-teeth method has a high accuracy but poor reliability. It’s difficult to be accurate and reliable [22]. Uzamis et al. [23] in Turkish population reported mandibular third molars began to calcify between ages 7 and 9 years. They also stated that in males, third-molar crypt formation occurred earlier in the mandibular arch than in the maxillary arch, whereas this was reversed in females. Specifically, they reported that third molar crypt formation can be observed at as early as 7 years in the mandible and 8 years in the maxilla [24]. Maxillary third-molar development was commonly more advanced than mandibular third-molar development [23]. Accuracy in the prediction of chronological age from dentition decreases after the age of 10 years [25]. Age estimation is especially difficult after the age of 14 years because all of the teeth, except unerupted ones, are in the process of completing their apical formation [26]. Apical formation can be considered complete in females and males at the ages of 16 and 17 years, respectively [27, 28]. Richardson [29] concluded that if the third molar has not appeared by the age of 10, there is a 50% probability of agenesis. The third molar is very variable in position, anatomy and development variations, agenesis [30]. It is noticed that the third molar formation and eruption occur faster in males than in females [27, 31]. According to Moore’s et al, these teeth erupt when the roots are 3/4 formed [32]. With completed mineralization of the mandibular third molars at stage H, 90% of the individuals are 18 years of age or older. 75% of male and female individuals are already 16 years old when they reach the developmental stage D [33, 34]. Meinl et al reported earlier third molar formation in females which becomes apparent at the early crown formation stages which show a slightly advanced development in females than in males. At the developmental stage B, girls reach the indicators for this stage about 0.4 years earlier than boys. But there is a faster rate of formation in the male
individuals that becomes strongly evident at stage E with boys reaching the corresponding criteria more than 2 years earlier. This result is consistent in the following stages with males being approximately 6 months ahead of the Austrian females [34].

Olze et al classified eruption stages: [35, 36]
Stage A Occlusal plane covered with alveolar bone.
Stage B Alveolar eruption; complete resorption of alveolar bone over occlusal plane.
Stage C Gingival emergence; penetration of gingiva by at least one dental cusp.
Stage D Complete emergence in occlusal plane.

Solaris method, in order to achieve higher accuracy in defining the stages of development towards apexification, two stages were added, F1 and G1, making ten stages of crown and root formation. For every patient, four measurements were scored [37]. This made it possible to also evaluate intra and inter-arch synchrony. The results and analyses were tabulated separately for each gender. If the third molar was not present, it was scored as letter code “N”. This was done to estimate the frequency of missing third molar development. When the third molar had atypical anatomy, it was scored as “U” [37].

Kohlers method: It is the forensic dental age estimation method which is used exclusively for third molars. Each developmental phase of the third molar is subdivided into 10 developmental stages and assigned an score ranging from 1 to 10. In case of a third molar with multiple roots, the least developed root was scored [39, 40].
Figure 1: Schematic drawings and definitions of the ten stages of figure 2: Developmental stages according to a modification crown and root formation used to score third molar development of the technique by Gleiser and Hunt, Kohler et al. [40. p 53] (modified from Demirjian et al.) [38, p532]

Table 1.Dental developmental stages of third molars describing crown and root formation. [38, p112]

Kullmans method, Kullman and coworkers [26, 41] studied the use of third molar development for age determination. They adopted subjective approach, using the typical determination of developmental stages, and objective approach, based on different digital measurements of root length [41] . If a subject presents with a third molar root developmental stage 1-5, individual is less than 18 years. If the root apices are closed (Stage 7), subject is atleast 18 years of age [42]. Levesque [27] reported that besides being ahead of girls in the root development, the course of development was also faster
The stages of root development by method adapted by Leif Kullman et al [26] are:

- Ri- R1/4 (1): Root development initiated but < 1/4 of the estimated root length.
- R1/4- R1/2 (2): Root development >1/4, but <1/2 of the estimated root length
- R1/2- R3/4 (3): Root development >1/2, but < 3/4 of the estimated root length
- R3/4- Rc (4): Root development >3/4, but < full estimated root length
- Rc- Ac (5): The full estimated root length is formed but apical closure not initiated.
- Ac- Aci (6): Apical closure started, but not closed.
- Aci (7): Apex is fully closed and root development completed.

Based on stages of root development of third molar teeth chronological age is as follows:
1. Stage 1 – 15 years 5 months
2. Stage 2 – 16 years 4 ½ months
3. Stage 3 – 16 years 10 ½ months
4. Stage 4 – 17 years 1 month
5. Stage 5 – 17 years 7 months
6. Stage 6 – 18 years 8 ½ months
7. Stage 7 – 19 years 6 months

References
2. U. Hägg, L. Matson, Dental maturity as an indicator of chronological age: the accuracy and precision of three methods. European J Orthodont. 1985;7; 24-34.
9. R.J. Hegde, P.B. Sood, Dental maturity as an indicator of chronological age: radiographic evaluation of dental age in 6 to 13 years children of Belgaum using Demirjian methods. J

in boys. This finding concurs very much in the present study. This is a surprising fact and is unique for third molar, for the other permanent teeth an advance for girls is usually seen.
29. Richardson, Late third molar genesis: its significance in orthodontic treatment, Angle

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