

Estimation of age from development and eruption of teeth

B. S. Manjunatha,
Nishit K. Soni

Department of Oral and
Maxillofacial Pathology,
K M Shah Dental College
and Hospital, Sumandeep
Vidyapeeth, Pipariya, Vadodara,
India

Address for correspondence:

Dr. B. S. Manjunatha,
Professor in Oral Pathology,
K M Shah Dental College
and Hospital, Sumandeep
Vidyapeeth, Vadodara, India.
E-mail: drmanju26@hotmail.com

Abstract

The developing dentition is used to assess maturity and estimate the age in many disciplines including anthropology, archeology, forensic science, pediatric dentistry and orthodontics. There is evidence that dental development is less effected than skeletal development by malnutrition and hormonal disorders. There are two methods of dental age assessment, radiographically and by clinically visualization of eruption of teeth. The clinical method to assess dental age is based on the emergence of teeth in the mouth. This method is more suitable since it does not require any special equipment, expertise and is more economical. Tooth formation is the best choice for estimating the age as variations are less as compared to other development factors. Eruption of teeth is one of the changes observed easily among the various dynamic changes that occur from the formation of teeth to the final shedding of teeth. The times of eruption of teeth are fairly constant and this can be made use of in ascertaining the average age of eruption of the tooth. Assessment of age of an individual by examination of teeth is one of the accepted methods of age determination.

Key words: Age estimation, dental age, forensic, tooth development and eruption

Introduction

The estimation of age is an important and is commonly carried in medico legal area. Assessment of age is often required while administering justice to an individual involved in the civil and the criminal litigation.^[1] Teeth are known to aid in personal identification and age estimation as they are highly durable and resist putrefaction, fire, chemicals etc.^[2] Dental age estimation in the living is mostly based upon non-invasive methods, which evaluate the timing and sequence of defined growth stages of the developing dentition and the sequence or modification of traits in the mature dentition and the surrounding tissues.^[3]


Eruption of teeth is one of the changes observed easily among the various dynamic changes that occur from the formation of teeth to the final shedding of teeth. The times of eruption of teeth are fairly constant and assessment of age of an individual by examination of teeth is one of the accepted methods of age determination. This fact can be made use of in ascertaining the average age of eruption of the tooth.^[1]

Discussion

History

The use of teeth for determining someone's age has its origin 170 years ago when tooth eruption was first used for dental age estimation in connection with child labor. In response to the need for age estimation of factory children who were not allowed to be employed under the age of nine and with a restricted working time between 9 years and 12 years of age.^[4]

In ancient times, age estimations of living adolescents were considered important. According to records in Ancient Rome adolescents were judged to be fit for service,

Access this article online	
Website: www.jfds.org	Quick Response Code 
DOI: 10.4103/0975-1475.132526	

as soon as the second molars had erupted completely.^[5] It was mainly dentists who had to carry out age estimations.^[6]

Earlier Charts and tables were used for the assessment of age during development period with the use of formation, eruption, and calcification of teeth. For this purpose, table of Krenfeld and Logan was further modified by Kronfeld and Schour (1939) is commonly used which has been accepted as standard for many years.^[7,8] Gordon *et al.*, described that during infancy and childhood, a fairly accurate estimate of age can be made from the study of teeth.^[9] Gonzales *et al.*^[10] described that the teeth may give, reliable information as to age in childhood and youth. Beyond adult life, the changes are too uncertain to be of value. Scot stated that if the third molars are fully erupted, it indicates that the age of an individual is above 17 years, and on X-ray examination if the root formation is not complete, one can definitely conclude that the person was probably less than 25 years of age.^[11]

Most of the earlier studies in European populations found differences in the pattern of deciduous tooth emergence in both different genders. These studies have showed that the anterior dentition in males is developing early relative to the female dentition and the pattern reverses so that females lead males in the emergence of the posterior deciduous dentition. Little is known about sex differences in the dental development and the emergence of non-European populations. The results supported that the pattern of developmental cross-over observed in other populations.^[12] They concluded that there is a little evidence to support the hypothesis of Tanguay *et al.*^[13]

Camps has described that after birth and during a child is developing, it is possible to arrive at a close estimation of age by the presence of the deciduous dentition at its stages of eruption and also the mixed dentition period and its stages of eruption of the permanent teeth and loss of deciduous teeth. He also pointed that state of eruption only gives an indication of age since eruption dates are subject to wide variations.^[14] Biggerstaff found that forensic dentist can estimate the age of a person by noting developing dentition. According to him, systemic observations can provide accurate age estimation depending upon the criteria used.^[15] Tedeschi *et al.*, have described that from birth to 6 months of life, accurate age estimation can be based on the mineralization of the deciduous crowns and from then up to 13 months of age, estimation may be determined by the state of eruption.^[16]

However, the socioeconomic status of the child could also play a role. Studies show that underprivileged children show comparative retarded eruption relative to their ethnic counterparts from higher socioeconomic status.^[17,18] This observed difference have been attributed to the effect of nutrition as studies point to earlier eruption times in well-nourished children.^[19] Eruption of the deciduous teeth

in moderate to severely malnourished children showed 5-29% increase in times of emergence.^[19] The effect of nutrition on the time of eruption of the deciduous teeth can be further corroborated by studies, which try to link the effect of breastfeeding on the timing of eruption. This is contrary to the observation by Holman and Yamaguchi^[19] who noted a selective effect of nutritional status on the timing of tooth eruption-poor nutrition was associated with delayed emergence, while medium nutritional status showed significant delay in the emergence of incisors and canines of the maxilla and all five teeth in the mandible. They also noted a delay in the emergence of the upper incisors and accelerated emergence of the upper second molar in children not breast-fed in Japan. Partial breastfeeding had no observed effect on tooth eruption.^[19]

Several biological factors have been associated with the timing of maturation. Since the development of teeth occurs during the prenatal period, it is appropriate to hypothesize that a shorter postnatal development may influence the development of deciduous dentition. It has been shown that dental development, dental eruption and tooth size may be delayed or reduced in low birth-weight (LBW) and prematurely born children.^[20-23]

A longitudinal study of dental development by Fearn and Brook^[20] in a group of LBW children was carried out to determine the tooth-crown size of primary molars and canines. The findings were compared to normal birth-weight (NBW) controls. Primary canines and molars were smaller in the LBW than the controls, with the significance values for the mesiodistal dimension of maxillary and mandibular canine compared to a non-significant difference for the buccolingual dimension of mandibular first primary molar. Within the LBW group, there was a positive correlation between birth weight and mesiodistal tooth size. Small primary tooth size in LBW children may be influenced by both genetic and environmental factors. The shorter prenatal growth period and poor perinatal and early postnatal development may influence the developing deciduous dentition.

Harris *et al.*^[21] found that the development of early forming teeth (permanent incisors and first 20 molars) was significantly delayed in LBW children and individuals with the poorest height-for-age had the greatest delay in tooth formation, but only teeth undergoing rapid differentiation neonatally were systematically affected.

Seow and Wan,^[22] compared the dimensions of the primary incisors from pre-term children and full-term controls. The results showed that there was a dose-response effect of birthweight on the tooth size. The very-low-birthweight teeth showed the smallest dimensions, the NBW controls the largest, and the low-birthweight teeth intermediate dimensions. They hypothesized that primary incisors from

children prematurely born with very LBW will have smaller dimensions compared with teeth from full-term children with NBW.

Helm and Prydso recorded permanent emergence of mandibular third molar at an early age of 14 years in 235 Danish Medieval skulls, 52 of whom were in various stages of mixed dentition. They argued that assessment of age at death could be made fairly accurately for the age group 5 to 30 years.^[24]

Kumar and Sridhar^[1] studied a total of 1008 individuals in between 5 years –and 14 years of age residing in Tirupati, Andhra Pradesh. This study was community based on eruption times of permanent teeth to establish age of the individual. The median age of the eruption was computed based on the concept of “Ex” which is defined as the age at which specified percent of individuals shows eruption of a given permanent tooth. The median age “E50” was computed by transforming of percentages to probits and plotting a graph between age and probits. The individual's age can be computed according to E50 value of permanent tooth, which erupted last. Given individuals probability being above or below the assessed age can be estimated by referring to graph and probit transformation table.

Kaul *et al.*^[25] studied deciduous teeth emergence of 312 children aged 4 months to 31 months with Punjabi parenthood. For calculating medium age of tooth emergence, they used probit analysis. They found earlier tooth emergence in females than their male counterparts. In comparison with other population, it was found that in general, mean number of emerged teeth in Punjabi children is more at most ages and with lower medium age of eruption for most teeth. Variability in the eruption time was highest in 16-17 and 20-21 months. Thus, their study suggests that the number of teeth can be used as a parameter for estimation of age.

Foti *et al.*^[26] studied for age determination both in living and dead children with the help of linear regression. The equation can be applied based on the number of erupted teeth and tooth germs detected during the clinical examination and radiograph. This equation helps in age estimation until 20 years of age.

Summary and Conclusion

The dental system is an integral part of the human body, its growth and development can be studied in parallel with other physiological maturity indicators such as bone age, menarche and height.^[27] Several authors have shown that dental parameters are more suitable for age estimation in children because the variability is lower since calcification rates of teeth are more controlled by genes than by environmental factors. Rate of formation of

the permanent teeth is not affected by premature loss of the primary teeth. Gingival emergence also called tooth eruption represents only one stage in the continuous process of dental eruption.^[28]

Many studies have concluded that tooth formation is a more reliable indicator of dental maturity than gingival emergence or eruption.^[29-31] Tooth eruption is mostly influenced by environmental factors such as available space in the dental arch, extraction of primary teeth, teeth tipping or impaction of teeth. Until quite recently, clinical eruption has been the only criterion used for dental maturity or dental age.^[28] The Demirjian scoring system based on the developmental stages of teeth is more useful since the tooth development is less influenced by environmental factors.^[29] Tooth development shows less variability than other developmental features and also low variability in relation to chronological age.^[32] Hertz observed a greater degree of association between dental age and chronological age than between dental and skeletal age.^[33] The application of clinical emergence as an indicator of maturity has been much debated.

References

1. Kumar CL, Sridhar MS. Estimation of the age of an individual based on times of eruption of permanent teeth. *Forensic Sci Int* 1990;48:1-7.
2. Swami D, Mishra VK, Bahal L, Rao CM. Age estimation from eruption of temporary teeth in himachal pradesh. *J Forensic Med Toxicol* 1992;9:3-7.
3. Schmeling A, Olze A, Reisinger W, Geserick G. Forensic age diagnostics of living people undergoing criminal proceedings. *Forensic Sci Int* 2004;144:243-5.
4. Saunders E. *The Teeth a Test of Age, Considered with Reference to the Factory Children, Addressed to the Members of Both Houses of Parliament*. London: Renshaw; 1837.
5. Müller N. To determine the age of people with special attention to wisdom teeth. Medical Thesis, Erlangen-Nuremberg, Germany, 1990.
6. Fendel H. Methods of radiological bone age assesement. *Radiologe* 1976;16:370-80.
7. Schour I, Massler M. The development of the human dentition. *J Am Dent Assoc* 1941;28:1153-60.
8. McDonald RE, Avery DR. Eruption of the teeth: Local, systematic and congenital factors that influence the process. *Dentistry for the child and adolescent*. 5th Ed. Delhi, India: All India Traveller Book Seller; 1988. p. 190-3.
9. Gordon I, Turner R, Price TW. *Medical jurisprudence*. 3rd ed. Edinburgh and London: Livingstone Ltd; 1953. p. 343-72.
10. Gonzales TA, Vance M, Helpert M, Umberger CJ. *Legal medicine pathology and toxicology*. 2nd ed. NY, USA: Appleton Century Crofts, Inc; 1954. p. 46.
11. Scot DB. Dental evidence in identification and criminology. In: Gradwohl, editor. *Legal medicine*. 3rd ed. Chicago, USA: A John Wright and Sons Ltd. Publication; 1954. p. 452-78.
12. Holman DJ, Jones RE. Longitudinal analysis of deciduous tooth emergence: III. Sexual dimorphism in Bangladeshi, Guatemalan, Japanese, and Javanese children. *Am J Phys Anthropol* 2003;122:269-78.

13. Tanguay R, Demirjian A, Thibault HW. Sexual dimorphism in the emergence of the deciduous teeth. *J Dent Res* 1984;63:65-8.
14. Camps FE. Gradwohl's legal medicine. 3rd ed. Bombay, India: K. M. Varghese Company; 1976. p. 140-1.
15. Biggerstaff RH. Forensic dentistry and the human dentition in individual age estimation. *Dent Clin North Am* 1977;21:167-74.
16. Tedeschi CG, Eckert WG, Tedeschi LG. Age determination: Forensic medicine, a study in trauma and environmental hazards. Vol 2. Philadelphia, London, Toronto: W B Saunders Company; 1977. p. 1124-34.
17. Enwonwu CO. Influence of socio-economic conditions on dental development in Nigerian children. *Arch Oral Biol* 1973;18:95-107.
18. Saleemi MA, Hägg U, Jalil F, Zaman S. Timing of emergence of individual primary teeth. A prospective longitudinal study of Pakistani children. *Swed Dent J* 1994;18:107-12.
19. Holman DJ, Yamaguchi K. Longitudinal analysis of deciduous tooth emergence: IV. Covariate effects in Japanese Children. *Am J Phys Anthropol* 2005;126:352-8.
20. Fearne JM, Brook AH. Small primary tooth-crown size in low birthweight children. *Early Hum Dev* 1993;33:81-90.
21. Harris EF, Barcroft BD, Haydar S, Haydar B. Delayed tooth formation in low birthweight African-American children. *Pediatric Dent* 1993;15:30-35.
22. Seow K and Wan A. A controlled study of the morphometric changes in the primary dentition of pre-term, very-low-birthweight children. *J Dent Res* 2000;79:63-9.
23. Seow K, Humphrys C, Mahanonda R, Tudehope D. Dental eruption in low birth-weight prematurely born children: a controlled study. *Pediatric Dent* 1988;10:39-42.
24. Helm S, Pryds U. Assessment of age-at-death from mandibular molar attrition in medieval Danes. *Scand J Dent Res* 1979;87:79-90.
25. Kaul SS, Pathak RK, Santosh. Emergence of deciduous teeth in punjabi children, North India. *Z Morphol Anthropol* 1992;79:25-34.
26. Foti B, Lalys L, Adalian P, Giustiniani J, Maczel M, Signoli M *et al.* New forensic approach to age determination in children based on tooth eruption. *Forensic Sci Int* 2003;132:49-56.
27. Hedge RJ, Sood PB. 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 Indian Soc Pedod Prev Dent* 2002;20:132-8.
28. Demirjian A, Goldstein H, Tanner JM. A new system of dental age assessment. *Hum Biol* 1973;211-27.
29. Willems G, Van Olmen A, Spiessens B, Carels C. Dental age estimation in Belgian children: Demirjian's technique revisited. *J Forensic Sci* 2001;46:893-5.
30. Willems G. A review of the most commonly used dental age estimation techniques. *J Forensic Odontostomatol* 2001;19:9-17.
31. Emilia A, Alexandru O, Szabo K, Tudor A, Bratu E. Dental maturity- A biologic indicator of chronological age: Digital radiographic study to assess dental age in Romanian children. *Int J Biol Biomed Eng* 2011;5:32-40.
32. Demirjian A, Goldstein H. New systems for dental maturity based on seven and four teeth. *Ann Hum Biol* 1976;3:411-21.
33. Demirjian A, Buschang PH, Tanguay R, Patterson DK. Interrelationships among measures of somatic, skeletal, dental, and sexual maturity. *Am J Orthod* 1985;88:433-8.

How to cite this article: Manjunatha BS, Soni NK. Estimation of age from development and eruption of teeth. *J Forensic Dent Sci* 2014;6:73-6.

Source of Support: Nil, **Conflict of Interest:** None declared

Announcement

“QUICK RESPONSE CODE” LINK FOR FULL TEXT ARTICLES

The journal issue has a unique new feature for reaching to the journal's website without typing a single letter. Each article on its first page has a "Quick Response Code". Using any mobile or other hand-held device with camera and GPRS/other internet source, one can reach to the full text of that particular article on the journal's website. Start a QR-code reading software (see list of free applications from <http://tinyurl.com/yzlh2tc>) and point the camera to the QR-code printed in the journal. It will automatically take you to the HTML full text of that article. One can also use a desktop or laptop with web camera for similar functionality. See <http://tinyurl.com/2bw7fn3> or <http://tinyurl.com/3ysr3me> for the free applications.