Age determination using Nolla's Method- A Radiographic Study

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Abstract

Background: Tooth development shows less variability in relation to chronological age. Tooth development is widely used to assess maturity and predict age. So, dental tissues can be used as a better aid for estimating age. Radiography plays an important role in humane age determination. There are five common methods to determine age using radiographs: Gleiser and Hunt (1955); Demijiran et al (1973); Gustafson and Koch (1974); Harris and Nortje (1984); Kullman et al (1992). Nolla's method (1960) was one of the various method used in age determination using radiographs. The aim is to estimate the age using Nolla's method of forensic age estimation.

Materials and Method: The present study was conducted on 20 selected individuals(10 males and 10 females) between age 9-17. Dental age assessment was done using OPG. The radiograph were compared with the Nolla's chart (fig-1) and dental age was assessed using age norms for upper and lower teeth including third molars proposed by Nolla. The chronological age and dental age obtained using Nolla's method was later subjected to statistical analysis.

Results: There is no significant difference between chronological age and estimated age with Nolla's method both in males and females i;e is 'p' value is not significant in both males and females (.161 in females and .757 in males).

Conclusion: Nolla's method of age determination was accurate in both males and females.No statistical significance was found between chronological age and estimated age for males and females. Hence Nolla's method can also be used in forensic dentistry.

Keywords: *Nolla's method , dental age, chronological age.*

Introduction

Growing individuals not only differ in the timing of the maturational events, but also in the sequence of maturational events. The developmental status of an individual can be assessed from various parameters such as height, weight, chronological age, secondary sexual characteristics, skeletal age, and dental age [(1)]. Age is one of the essential factors, which play an important role in every aspect of life. The assessment of age is useful in planning treatment of orthodontic and pedodontic patients, and in forensic medicine and forensic odontology and also provides valuable information when the birth date is not available, as in case of illegal immigrants. Its use is increasing in both civil and criminal matters and is also helping in the identification of age at death of a dead individual in mass disasters and natural calamities. In children, age determination from the teeth is relatively simple and accurate; it is based on the stage of development and eruption of teeth [(2)]. The branch of radiology comes handy which provides baseline data for age estimation [(3)]. The aim of an ideal age estimation technique is to arrive at an age as close to the chronological age as possible. Various age estimation methods have been tested and reported in the literature [(4)]. Visual, radiographic, chemical and histological methods are various methods of estimating age [(3)].

Visual method: It is based on of the sequence of eruption of the teeth and the changes that are caused due to function such as attrition, changes in colour are indicators of ageing.

Radiographic method: Radiographs of the dentition can be used to determine the stage of dental development of the teeth. This method is the most commonly used method as it aids in age determination over a long span of time.

Histological method: Histological methods require the preparation of the tissues for detailed microscopic examination which can determine more accurately the stage of development of the dentition. This technique is more appropriate for post-mortem situations.

Chemical analysis: The chemical analysis of dental hard tissues determines alterations in ion levels with age. These techniques are not of great value to the forensic odonatologist and future developments may provide adjunctive means of collecting evidence of value in the dental framework.

Radiograph plays an important role in human age determination. Demirjian and Nolla's method was widely used age estimation methods using radiographs since it utilizes maturation of teeth for age assessment. Demirjian et al classified teeth development into 8 stages which includes only 7 mandibular teeth and concluded a method for age estimation [1]. This method is most widely accepted [5,6]. Later, Acharya included the 3rd molar as well and arrived at a formula for Indian population [7]. Nolla classified the teeth development into 10 stages and arrived at a method [8]. Tooth development shows less variability than other developmental features and also low variability in relation to chronological age [9]. Dental tissues are resistant to mechanical, chemical and thermal changes and is suitable for estimation of age because it is continuous, progressive process that can be followed radiographically from the crypt stage to the closure of root apex. Dental age estimation is based upon the rate of development and calcification of tooth buds and the progressive sequence of their eruption in the oral cavity. Also tooth development is uniform and is less influenced by external factors such as malnutrition, diseases and mental stress and less affected by endocrine status [10]. As radiographs provide a two-dimensional view of the dental tissues it is very much helpful in estimating age. With this background the aim of our present study was done with an objective to assess age by using Nolla's method and to estimate the efficacy of Nolla's method.

Materials and Method

The present study was conducted on randomly selected 20 individuals. Among them, 10 were males (50%) & 10 were females (50%). The age ranged from 9-17 years. Age assessment was done using radiographs (OPG). A brief history of each individual including name, age, sex, date of birth, name of the school and address were recorded. Age and date of birth was reverified using valid identity proofs. Chronological age was calculated from date of birth to date of radiograph being taken. Chronological age= Date of radiograph taken-Date of birth. Dental age or estimated age was calculated from the radiographs taken using Nolla's normalized table for boys and girls. The results were then subjected to statistical analysis.

Criteria for sample collection:

- None of the subjects selected had undergone orthodontic treatment
- All the subjects selected were moderately built and were of growing age with no history of deformities, bone diseases, and major illness in the past
- None of the subjects showed any facial asymmetry.
- No history of trauma or surgery was reported in the dentofacial region
- The subjects with muscular dystrophy, congenital abnormalities affecting growth and development, or traumatic injuries of hand wrist and jaws were excluded.
- The presence of all the eight left or right maxillary and mandibular teeth (erupted or not) was considered.

Nolla's method:

It was devised by C M Nolla [11] in 1960. Nolla evaluated the mineralization of permanent dentition in 10 stages. Each tooth is assigned a reading and a total of the maxillary and mandibular teeth are made. The total is compared with the pre-determined values in the norms table to determine the age. This method is one of the most acuurate and reliable method as girls and boys are dealt separately.

The radiograph was compared with the Nolla's developmental stages (fig-1) and dental age was assessed using age norms for upper and lower teeth for females (table-1) and males (table-1) including third molars proposed by Nolla.

Fig-1

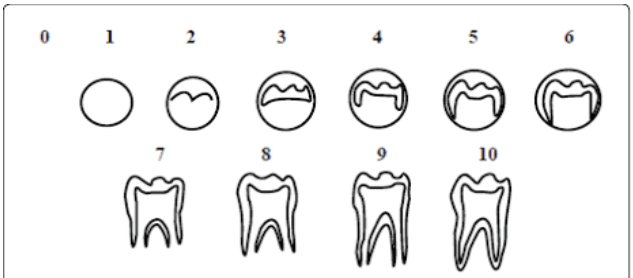


Figure 1: showing Nolla stages of development of third molar. Stage 0 - absence of crypt, Stage 1 – presence of crypt, Stage 2 – Initial calcification, Stage 3 – 1/3rd crown completed, Stage 4 – 2/3rd crown completed, Stage 5 – crown almost completed, Stage 6 – crown completed, Stage 7 – 1/3rd crown completed, Stage 8 – 2/3rd crown completed, Stage 9 – root completed, apex open, Stage 10 – apical foramen closed.

Nolla's developmental stages:

Stage 10: Apical end of root completed

Stage 9: Root almost complete; open apex

Stage 8: Two-third of root completed

Stage 7: One-third of root completed

Stage 6: Crown completed

Stage 5: Crown almost completed

Stage 4: Two-third of crown completed

Stage 3: One-third of crown completed

Stage 2: Initial calcification

Stage 1: Presence of crypt

Stage 0: Absence of crown.

Table 1- Norms for males and females including third molars.

	Age in years	Sum of stages of 8 mandibular teeth	Sum of stages of 8 maxillary teeth.	Sum of stages of 16 maxillary and mandibular teeth.
Males	7	54.2	49.5	103.7
	8	59.5	57	116.5
	9	66.7	62	112.7
	10	67.5	66.6	134.1
	11	70.0	68.3	138.3
	12	72.6	73.2	145.7
	13	74.7	75.4	150.1
	14	75.9	76.5	152.4
	15	76.7	77.1	153.8
	16	77.5	78	155.5
	17	78.0	78.7	156.7
Females	7	49.5	45.5	95
	8	55.1	51.8	106.9
	9	59.7	57.3	117
	10	63.5	61.8	125.3
	11	66.7	65.6	132.3
	12	69.8	69.3	139.1
	13	72.3	72.2	144.5
	14	74.3	74.4	148.7
	15	75.9	75.9	151.8
	16	77.3	77.7	155
	17	77.6	78	155.6

The estimated age was obtained using Nolla's method and was compared with chronological age and was subjected to statistical analysis.

Results

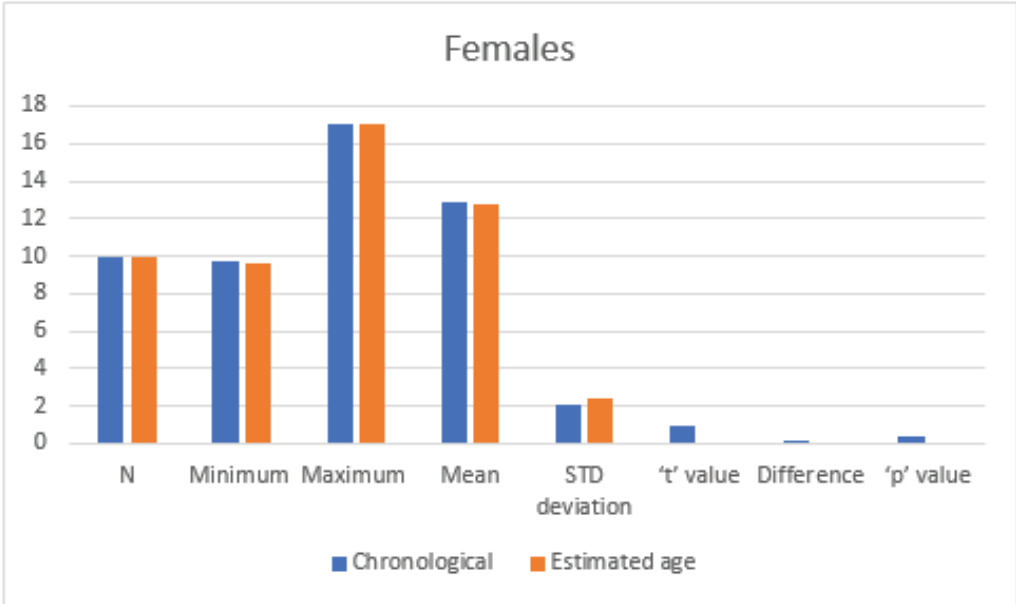
This study comprised of 20 patients between the age group of 9-17 years and the method used to determine the age was Nolla's method. Chronological age and estimated was calculated for females and males. Paired 't' test was done (graph-1,2)(table 2,3). Distribution of patients with their gender, chronological age with minimum and maximum and the estimated age using Nolla's method with minimum and maximum was calculated. Mean and standard deviation was also calculated for females and males (table-2,3). There is no significant difference between chronological age and estimated age with Nolla's method both in males and females i;e is 'p' value is not significant in both males and females (.376 in females and .468 in males)

Table-2- Females (Paired 't' test)

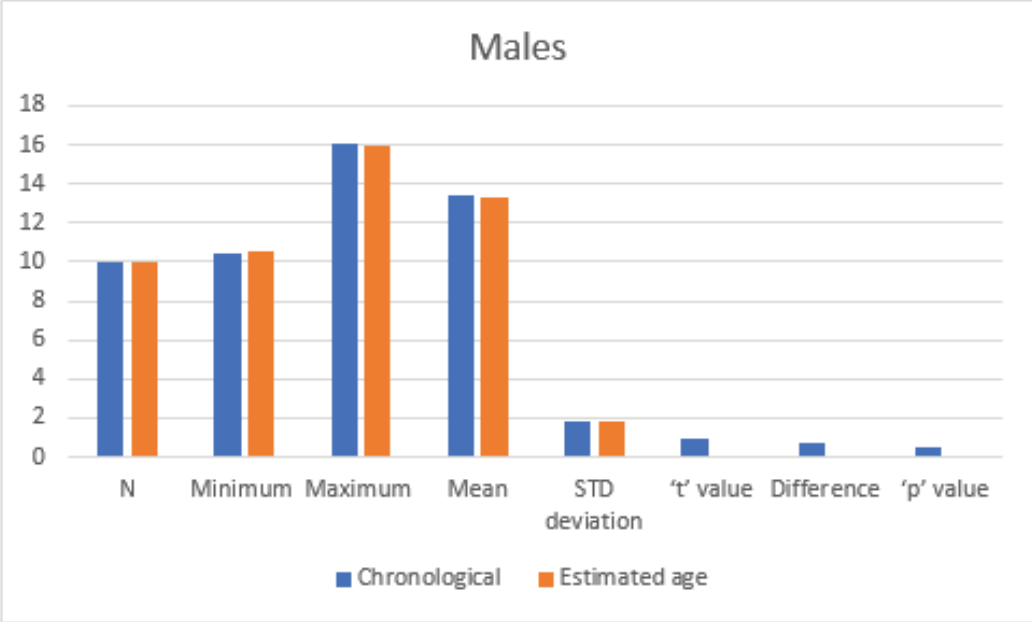
	N	Minimum	Maximum	Mean	Std. Deviation	't' vale	Difference	'p' value
Chronological age	10	9.70	17.00	12.8920	2.12701	.930	.161	.376 Not Significant
Estimated age	10	9.60	17.00	12.7310	2.40482			

Table - 3 – Males (Paired 't' test)

	N	Minimum	Maximum	Mean	Std. Deviation	't' vale	Difference	'p' value
Chronological age	10	10.40	16.10	13.3700	1.84695	.930	.757	.468 Not Significant
Estimated age	10	10.50	16.00	13.2910	1.84226			



Graph-1



Graph-2

Discussion

Our study comprises 20 individuals which includes 10 females and 10 males of age 9-17 years. Out of 10 female individuals, five females showed dental age underestimation by 5 months and 2 months and three female individuals showed dental age underestimation by 1 month. Two females showed exact correlation with estimated age

Out of 10 male individuals, three male individuals showed dental age underestimation by 3 months and 2 months. Four male individuals showed dental age overestimation by 5 months, 3 months, 2 months and 1 month. Three male individuals showed exact correlation with estimated age. Difference of less than 6 months was considered as normal [12].

Distribution of patients with their gender, chronological age with minimum age of 9.70 for females and 10.40 for males and maximum of 17.10 for females and 16.10 for males and the estimated age using Nolla's method with minimum age of 9.60 for females and 10.50 for males and maximum of 17 for females and 16 for males is shown in table 2 and table 3 and graph 1 and graph 2.

There is no significant difference between chronological age and estimated age with Nolla's method both in males and females. 't' value was 0.930 for both males and females. 'p' value was .161 in females and .757 in males (table-2,3) and (graph-1,2).

It also shows mean and standard deviation in two methods. Mean chronological age was 12.8920 and standard deviation of 2.12701 was seen in females and mean of 13.3700 and standard deviation of 1.84695 was seen in males. The mean of estimated age by Nolla's method was 12.7310 and standard deviation of 2.40482 was seen in females and mean of 13.2910 and standard deviation of 1.84226 was seen in males. Average chronological age and average estimated age by Nolla's method shows statistically non-significant difference and good correlation was found. (table-2,3).

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 [13].

Nolla's method was introduced by Nolla in 1960. In this method the staging is done based on calcification of individual tooth which is from stage 0 to 10. It has additional staging of mineralization which proves it to be more accurate and reliable and thus making it the most commonly used method around the world [14].

Miloglu et al conducted a study on Turkish males using the Nolla's method and inferred that the mean difference in the dental and chronological age

ranged from -0.5 to 0.0 years proving the accuracy of Nolla's method above any other method of dental age estimation, similar statistics were obtained by Caro et al (2001) [15, 16]. And the study by Green found that dental age showed the highest degree of correlation with chronological age [17]. Lauterstein supported this study by his study finding that chronological age bore a positive correlation to the number of erupted teeth [18]. Nolla's method was also used on Maltese school children in 2005 and no significant difference was found between dental age and chronological age [19]. Another study was conducted on Brazilian population in 2007 to evaluate the applicability of the methods proposed by Nolla and Nicodemo and colleagues for assessing dental age and its correlation to chronological age and concluded that the mean difference between true and estimated age for males and females was underestimated and the use of correction factors were recommended [20].

In 2011 Nolla's method was applied to investigate whether or not this method is appropriate for Turkish children for the determination of the dental age. The study suggested that the method is suitable for Turkish boys, but it is less suitable for Turkish girls [21]. In another study conducted in 2012 Validity of Demirjian and Nolla methods for dental age estimation for North Eastern Turkish children were compared and Nolla's method was found to be a more accurate method for estimating dental age in North Eastern Turkish population [22].

The present study agrees with the previously mentioned analysis by various researchers and proves that Nolla's method of estimating dental age by analysing 10 stages of teeth development is better as compared to other methods and easy to perform.

Conclusion

Nolla's method can be considered as a good method of dental age assessment. No statistical significance was found between chronological age and age estimated using Nolla's method for males and females. It could be stated that assessment of maturation is of utmost importance in certain orthodontic protocols such as for myofunctional therapy and the importance of age estimation includes an assessment of minor/major status in individuals without legal documents, Nolla's method, the widely used method shall be a reliable method. And also, dental radiographs have been used in forensic applications mainly for age estimation [23]. Besides the technique is cost efficient as compared to other methods of age estimation and is readily available across all dental clinics.

Ethical Clearance:Nil

Source of Funding:self

Conflict of Interest: Nil

References

1. Demirjian A, Goldstein H, Tanner JM. A new system of dental age assessment. Hum Biol 1973; 45:211-27.
2. Vane Swetah. C. S., Dr. Nithya Jagannathan Age estimation using pulp/tooth volume ratio of Mandibular first premolar obtained from Cone Beam Computed Topography in Indian population; Int. J. Pharm. Sci. Rev. Res., 47(2), November - December 2017; Article No. 21, Pages: 119-122
3. Willems G, Moulin-Romsee C, Solheim T. Non-destructive dental-age calculation methods in adults: Intra and inter observer effects. Forensic Sci Int. 2002; 126:221-6[Pub Med].
4. Ritika Gupta, Harsh Rajvansh, Hafsa Effendi, Sarah Afridi, Kiran Kumar Vuyyuru, Bhuvana Vijay, Manu Dhillon Dental age estimation by Demirjian's and Nolla's method in adolescents of Western Uttar Pradesh.
5.] Demirjian A, Goldstein H. New systems for dental maturity based on seven and four teeth. Ann Hum Biol 1976; 3: 411–421.
6. Cameriere R, Flores-Mir C, Mauricio F, Ferrante L. Effects of nutrition on timing of mineralization in teeth in a Peruvian sample by the Cameriere and Demirjian methods. Ann Hum Biol 2007; 34:547-556.
7. Acharya AB. Age estimation in Indians using Demirjian's 8-teeth method. J Forensic sci. 2011; 56:124-7[Pub Med]
8. Kiran Sachan, V.P. Sharma, Pradeep Tandon. Reliability of Nolla's dental age assessment method for Lucknow population. J Ped Dent. 2013 1(1):8-13.
9. Balwant Rai, S.C. Anand. Tooth Developments: An Accuracy of age Estimation of Radiographic Methods. World Journal of Medical Sciences. 2006;1(2):130-132.
10. McKenna CJ, James H, Taylor JA, Townsend GC. Tooth development standards for South Australia.

Aust Dent J 2002; 47:223-7.

11. Nolla CM The development of permanent teeth. J Dent Child 1960; 27:253-266.
12. Deepthy Thomas, Prashanth Shenai, Lakshmikanth Chatra, Veena K M, Prasanna Kumar Rao, Rechana Prabhu, Shahin K A, Prathima Shetty Age Assessment Using Nolla's Method in a Group of Mangalore Population: A Study on 25 Children Journal of Contemporary Medicine 2014;4(3): 121-127.
13. 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.
14. Bolanos MV, Manrique MC, Bolanos MJ, Briones MT. Approaches to chronological age assessment based on dental calcification. Forensic Sci Int 2000; 110:97-106.
15. Miloglu O, Celikoglu M, Dane A, Cantekin K, Yilmaz AB. Is the assessment of dental age by the Nolla method valid for eastern Turkish children? J Forensic Sci 2011; 56:1025-1028.
16. Caro, A.C. and I.C. Contreras, 2001. Analysis and comparison de cuatro methods radiographics para determinar la ede dental en dientes permanent. Int. J. Dent. Anthropol., 2: 9-15.
17. Green LJ. Interrelationship among height, weight and chronological, dental and skeletal ages. Angle Orthod 1961; 31:189-93.
18. Lauterstein AM. A cross-sectional study in dental development and skeletal age. J Am Dent Assoc 1961; 62:161-7.
19. Kevin Briffa, Nicholas Busuttil Dougall, James Galea,David Mifsud, Simon Camilleri. Chronologic and Dental Ages of Maltese Schoolchildren - A Pilot Study. Malta Medical Journal. 2005; 17:31-35.
20. Lucio Mitsuo Kurita, Alynne Vieira Menezes, Marcia Spinelli Casanova, Francisco Haiter-Neto. Dental maturity as an indicator of chronological age: radiographic assessment of dental age in a brazilian population. J Appl Oral Sci. 2007;15(2):99-10.
21. Ozkan Miloglu, Mevlut Celikoglu, Asim Dane,Kenan Cantekin,Ahmet Berhan Yilmaz. Is the Assessment of Dental Age by the Nolla method Valid for Eastern Turkish Children? Journal of forensic sciences. 2011;56(4):1025-1028.
22. Bilge Nur, Adem Kusgoz, Mehmet Bayram, Mevlut Celikoglu, Metin Nur, Saadettin Kayipmaz, SinaYildirim. 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(5):871-877.
23. Uma Maheswari T N. Dental biometrics. Int J Forensic Odontol 2017; 2:45