Original Article

Braz J Oral Sci.
October|December 2010 - Volume 9, Number 4

Chronological table of third molar mineralization in a survey in the state of Alagoas, Brazil

Ana Paula Cavalcante Carneiro[1], João Alfredo Tenório Lins Guimarães[2], Roseli Mayumi Ikeda e Silva[3], Adriana Paula Costa e Silva Santiago[4], José Rodrigues Laureano Filho[5]

[1]DDS, Undergraduate student, Dental School, University of Pernambuco, Recife, PE, Brazil
[2]DDS, MS, Assistant Professor, Forensic Dentistry, State University of Alagoas, Maceió, AL, Brazil
[3]DDS, Institute of Forensic Medicine, Maceió, AL, Brazil
[4]DDS, MS, PhD, Professor, Forensic Dentistry, Dental School, Federal University of Pernambuco, Recife, PE, Brazil
[5]DDS, MS, PhD, Associate Professor, Forensic Dentistry, Dental School, University of Pernambuco, Recife, PE, Brazil

Abstract

Aim: The aim of this study was to develop an age estimation table based on mineralization stages of third molars in a survey in the state of Alagoas, Brazil. Forensic dentistry has largely contributed to solve age estimation cases. Radiographic study on tooth mineralization stages has shown major importance on age estimation with forensic application. **Methods:** This investigation was a cross-sectional study developed at the clinic of the local branch of the Brazilian Dental Association in Alagoas. Three hundred and twelve patients of both genders aged 9 to 21 years were enrolled. Three calibrated examiners (kappa=0.789, p<0.001) determined the mineralization stages of each third molar from radiographs collected in the survey. The age of each patient was also recorded. **Results:** A third molar chronological mineralization table based on the study's survey was developed. There was correlation (Spearman=0.869; p<0.01) between real and estimated ages, mainly when both upper and lower third molars were considered together. **Conclusions:** It is important to develop regional age estimation tables based on local surveys mainly considering ages of forensic interest.

Keywords: age determination by teeth, molar third, radiography, panoramic.

Introduction

Over the last few years, age evaluation of live subjects has become very important in forensic sciences[1]. There are several situations in which age estimation procedures are required. Some specific ages present legal importance worldwide. In the Brazilian legal system, age is commonly mentioned as a requirement for some civil acts or characterization of facts of legal interest.

Concerning civil situations, subject's legal capacity may be determined by age estimation. Also, people with incorrect birth certificates often need age estimation procedures to obtain regular documents. In adoption cases, it is frequently necessary to develop age estimation procedures to fulfill the purpose of the process.

In criminal circumstances, lack of documents to confirm chronological age may have important consequences. In Brazil, the most common are the determination of criminal age (18 years old), age limit of 14 years old to establish the crime "rape of vulnerable", and also to determine whether a subject involved on a

Received for publication: May 07, 2010
Accepted: December 05, 2010

Correspondence to:
Ana Paula Cavalcante Carneiro
Rua: Escritor Antônio Saturnino de Mendonça Júnior, nº 99, apto 702
Jatiúca, Maceió, Alagoas, Brazil,
CEP: 57036-420
E-mail: analegista@hotmail.com

crime or violent situation is a child (less than 12years old) or an adolescent (more than 12 and less than 18 years old). Still concerning criminal situations, there is a requirement of age estimation to help identifying non-identified corpses.

A number of methods to achieve age estimation have been described[2]. Studies have distinguished evaluation of dental mineralization stages[3-4], cervical vertebra maturation index[5], carpal maturation[5], and tooth eruption chronology[1]. Frequently tooth mineralization methods have been used for age estimation, mainly among children[6]. Thus dental radiology plays an important role as a complementary specialty, helping forensic dentistry to perform age estimation procedures[7].

Kurita[8] has demonstrated that age estimation through tooth mineralization methods present strong correlation with chronological age and there is no statistically significant difference from bone methods.

Almeida[9] mentions that human tooth development takes place up to 21 years old. The same author assumes that teeth are the best body structures for age estimation because they are poorly affected by systemic and nutrition alterations that can influence bone development and maturity.

An age estimation method based on a Canadian survey that has been largely used worldwide through tooth mineralization study was first described in 1973 by Demirjian et al.[10]. Over the years, the applicability of Demirjian's method has been tested in various countries all over the world[11-16]. Some of these studies[11-13,15] have suggested the need of local adjustment to the method development. Studies have shown that global differences concerning Demirjian's method are due to differences in population composition[14].

In Brazil, a tooth mineralization table developed by Nicodemo et al.[17] in Brazilian Southern region survey has been used as a reference pattern in many age estimation situations. It would be useful to develop specific tooth mineralization patterns for each region, considering population differences in a continental country such as Brazil[8].

The purpose of this study was to develop an age estimation table based on mineralization stages of third molars in a survey conducted in the Brazilian Northeastern state of Alagoas, Brazil.

Material and methods

This study was developed following ethical principles for research involving human subjects and was evaluated and approved by the Ethics Committee of University of Alagoas (protocol number 927/08).

This investigation was a cross-sectional study developed at the clinic of the local branch of the Brazilian Dental Association in Alagoas (BDA/AL), Brazil. All preoperative panoramic radiographs from the records of all patients undergoing orthodontic treatment at BDA/AL were reviewed. Three hundred and twelve panoramic radiographs from subjects aged 9 to 21 years were included. Exclusion criteria were: history of chronic systemic disease, dentofacial syndromes, history of long-term medication use, extracted or missing third molars, and individuals born in other Brazilian states but Alagoas. These data were accessed from patients' files.

Three examiners, forensic dentists from the Forensic Medicine Institute of Maceio, Alagoas were calibrated to detect the different tooth mineralization stages. First, the examiners evaluated third molar mineralization stages on 10 previously selected panoramic radiographs. The same radiographs were reevaluated after a 15-day interval, showing substantial agreement[18] among examiners (kappa = 0.789; $p < 0.001$).

Panoramic radiographs were evaluated with the aid of light-boxes and magnifiers without direct incidence of ambient light. The mineralization stage for each tooth was scored ranging from 1 to 8, according to the mineralization stages described by Nicodemo et al.[17]. Additional data included gender and chronological age for each subject. Besides, age estimation for each subject was performed based on mineralization values for third molars proposed by Nicodemo et al.[17].

Data were stored in the Statistical Package for the Social Sciences (SPSS, version 15.0 for Win, SPSS Inc., Chicago, IL, USA). Age means, standard deviations and 95% confidence interval were calculated for each mineralization stage.

Linear regression graphs were built and Spearman's correlation test ($p < 0.01$) was applied to determine the strength of correlation between chronological and estimated ages. Independent Student's t-test was applied ($p < 0.05$) to measure differences of chronological age means of each mineralization stage between male and female groups.

Results and Discussion

From the 312 panoramic radiographs evaluated, 118 (37.8%) were from male and 194 (62.2%) from female individuals.

Tables 1 and 2 show age means (in months), confidence interval and standard deviations for each mineralization stage of upper and lower third molars, respectively. Concerning ages of forensic interest, according to the confidence intervals presented in our survey, it can be stated that, when the third molar is classified in the 5th to 8th stage of mineralization, there is no doubt that the analyzed subject is above 12 years of age. To solve doubts concerning the criminal age of 14 years old, third molars in the 6th stage of mineralization are required at least. On the other hand, concerning majority determination, it can just be affirmed that the individual is 18 years old or older if third molars in the 8th stage of mineralization are present (closed apex).

Unlike reported in previous studies, this survey did not show significant differences (t-test, $p > 0.05$) between the age means and the mineralization stages concerning gender (Tables 3 and 4), except for stage 7 of upper third molars (Table 3), which showed a higher mean for female

Table 1. Tooth mineralization chronology of upper third molars*.

Mineralization stages	N (%)	Age means (months)	95% confidence interval	StandardDeviation
1	16 (5.7)	116.31	107.33 – 125.28	16.84
2	20 (7.1)	127.40	120.97 – 133.82	13.72
3	34 (12.0)	132.14	124.45 – 139.84	22.05
4	52 (18.4)	142.07	136.91 – 147.23	18.53
5	57 (20.2)	160.77	155.39 – 166.15	20.18
6	38 (13.7)	183.21	176.27 – 190.14	21.10
7	39 (13.8)	210.51	203.37 – 217.64	22.01
8	26 (9.2)	235.84	228.57 – 243.11	18.00

*Data from 282 subjects.

Table 2. Tooth mineralization chronology of lower third molars*.

Mineralization stages	N (%)	Age means (months)	95% confidence interval	StandardDeviation
1	18 (6.0)	117.94	109.39 – 126.49	17.19
2	20 (6.7)	116.40	111.24 – 121.55	11.00
3	42 (14.2)	133.00	127.43 – 138.56	17.87
4	64 (21.6)	142.31	138.26 – 146.35	16.18
5	53 (17.9)	163.75	157.35 – 170.15	23.22
6	41 (13.8)	184.53	178.86 – 190.21	17.98
7	38 (12.8)	212.42	205.14 – 219.69	22.13
8	20 (6.7)	236.80	227.62 – 245.97	19.60

*Data from 296 subjects.

subjects. Despite these results, correlation between chronological and estimated ages was stronger in female lower third molars (Spearman = 0.883; $p < 0.01$) and weaker in male lower third molars (Spearman = 0.832; $p < 0.01$) (Table 5).

Compared to those values suggested by Nicodemo et al.[17], this survey's general age means were higher until the 4th mineralization stage and lower concerning the other stages. Kurita et al.[19] (2007), studying a sample of Fortaleza (another Northeastern Brazilian state), demonstrated that Nicodemo's method underestimated the chronological ages of both genders. Therefore, this method does not present a variation pattern, being below or above the chronological age depending on the age of the considered subjects[6].

Figures 1-3 show correlations between chronological

Table 3. Tooth mineralization chronology of upper third molars according to sex.

Stages	Male(n=106)		Female(n=177)	
	N (%)	Age means (months±SD)	N (%)	Age means (months±SD)
1	5 (4.7)	120.60±9.47	11 (6.2)	114.36±19.40
2	7 (6.6)	129.00±6.95	13 (7.3)	126.53±16.48
3	18 (17.0)	132.00±16.16	16 (9.0)	132.31±27.82
4	21 (19.8)	144.61±21.79	31 (17.5)	140.35±16.11
5	20 (18.8)	159.25±19.51	38 (21.4)	161.57±16.11
6	12 (11.3)	180.75±17.76	26 (14.7)	184.34±22.72
7	9 (8.5)	197.88±16.55*	30 (16.9)	214.30±22.25*
8	14 (13.2)	234.42±19.00	12 (6.8)	237.50±17.43

SD: Standard Deviation
*Different values at $p<0.05$ (t test)

Table 4. Tooth mineralization chronology of lower third molars according to sex.

Stages	Male(n=115)		Female(n=159)	
	N (%)	Age means (months±SD)	N (%)	Age means (months±SD)
1	6 (5.2)	127.83±16.04	5 (3.1)	113.00±16.11
2	12 (10.4)	120.08±10.43	4 (2.5)	109.85±10.33
3	18 (15.6)	135.66±17.56	16 (10.0)	131.00±18.20
4	25 (21.7)	145.32±18.86	36 (22.6)	140.38±14.13
5	21 (18.2)	158.28±21.98	32 (20.1)	167.34±23.65
6	11 (9.5)	183.18±17.08	30 (19.1)	185.03±18.55
7	12 (10.4)	207.00±20.46	26 (16.3)	214.92±22.80
8	10 (8.7)	232.40±23.11	10 (6.2)	241.20±15.28

SD: Standard Deviation

Table 5. chronological and tooth age correlation according to sex.

	Female Nicodemo			Male Nicodemo		
	upper	lower	General	upper	lower	General
Sperman's correlation	0.856*	0.883*	0.873*	0.856*	0.832*	0.859*

*Significant correlation (p<0.01)

and estimated ages for upper and lower third molars according to Nicodemo's data[17]. Correlation coefficients (Spearman's test) were 0.853 (upper teeth), 0.867 (lower teeth) and 0.869 (both upper and lower teeth), suggesting that the combination of upper and lower tooth values leads to a discrete increase of Spearman's coefficient between the estimated and chronological ages.

In this survey, although all values have suggested significant correlations ($p < 0.01$), it is evident that there are significant discrepancies between the chronological and estimated ages. The practical importance of these differences comprises the responsibility that expert dentists assume when apply age estimation methods in order to formulate reports that can determine the future of examined individuals concerning criminal issues.

The use of age estimation methods based on mineralization stages of third molars is very profuse in the specialized literature. In our sample, it was evident that there are substantial differences between estimated and chronological ages in the various mineralization stages.

In this study, a chronological mineralization table based on third molars was developed. According to the obtained results, we suggest the development of regional tables of tooth mineralization chronology that can decrease the discrepancies between the estimated and chronological ages in dental examinations of forensic interest.

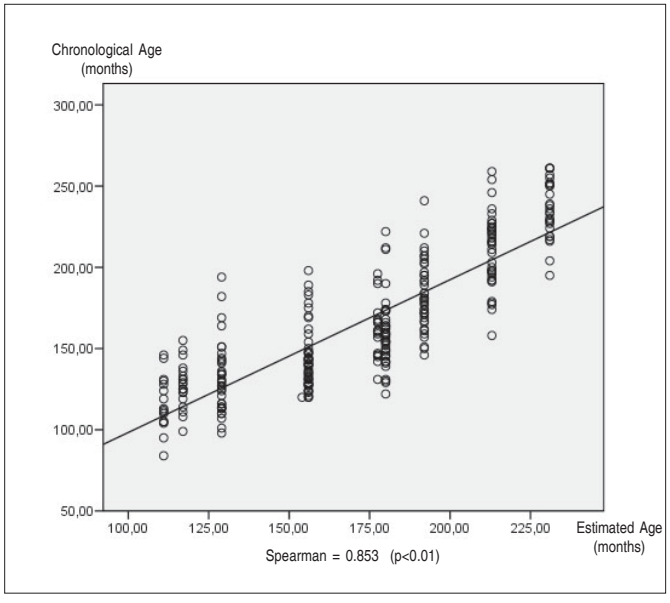

Fig. 1. Linear regression curve correlating estimated and chronological ages. (Upper third molar mineralization evaluation).

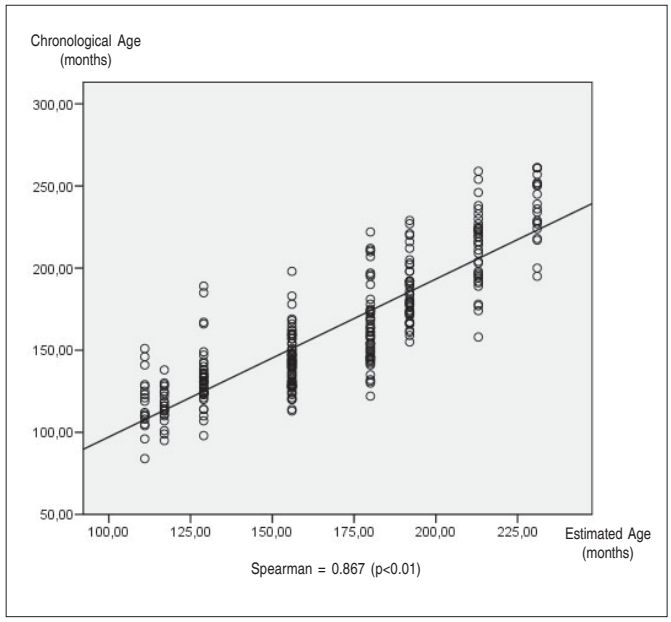

Fig. 2. Linear regression curve correlating estimated and chronological ages. (Lower third molar mineralization evaluation).

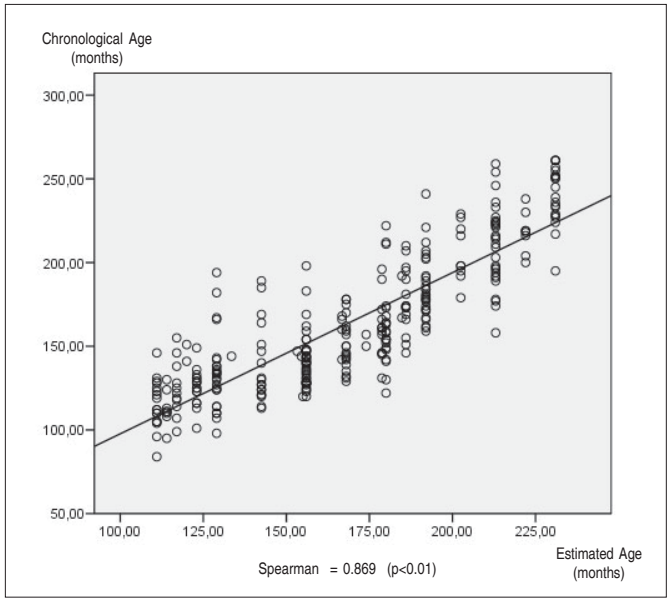

Fig. 3. Linear regression curve correlating estimated and chronological ages. (Third molar mineralization evaluation).

References

1. Olze A, Peschke C, Schulz R, Schmeling A. Studies of the chronological course of wisdom tooth eruption in a German population. J Forensic Leg Med. 2008; 15: 426-9.
2. Schmidt CM. Estimativa da idade e sua importância forense [dissertation]. UNICAMP/FOP; 2004.
3. Costa FE. Estimativa de idade em radiografias panorâmicas através dos estágios de calcificação de Nolla [dissertation]. UNICAMP/FOP; 2001.
4. Fereira AE, Fereira J, Céspedes M, Barrios F, Ortega A, Maldonado Y. Empleo de la edad dental y la edad osea para el cálculo de la edad cronológica com fines forenses, en niños escolares com alteraciones em el estado nutricional, en Maracaibo, estado Zulia – estudo preliminar. Acta Odontol Venez. 2007; 45: 3-10.

5. Camargo GTL, Cunha GTE. Estudo do sincronismo entre índice de maturação das vértebras cervicais, idade dentária e idade carpal com a idade cronológica. Sotau Rev Virtual Odontol. 2007; 2: 2-7.
6. Gonçalves ACS, Antunes JLF. Estimativa da idade em crianças baseada nos estágios de mineralização dos dentes permanentes, com finalidade odontolegal. Odontol Soc. 1999; 1: 55-62.
7. Gruber J, Kameyama MM. O papel da Radiologia em Odontologia Legal. Pesq Odontol Bras. 2001; 15: 263-8.
8. Kurita LM. Aplicabilidade de métodos de estimativa de idade óssea e dentária em brasileiros, cearenses [thesis]. UNICAMP/FOP; 2004.
9. Almeida CSL. Estimativa da idade por radiografias panorâmicas em indivíduos melanodermas. Piracicaba, SP: [s.n.], 2002. 171p.
10. Demirjian A, Goldstein H, Tanner JM. A new system of dental age. Hum Biol. 1973; 45: 211-7.
11. Koshy S, Tandon S. Dental age assessment: The applicability of Demirjian's method in South Indian children. Forensic Sci Int. 1998; 94: 73-85.
12. Landeira AC, Argote JL, Rodríguez MM, Calvo MSR, Otero, XL, Concheiro, L. Dental age estimation in Spanish and Venezuelan children. Comparision of Demirjian and Chaillet's scores. Int J Legal Med. 2010; 124: 105-12.
13. Leurs IH, Wattel E, Aartman IHA, Etty E, Andersen PB. Dental age in Dutch children. Eur J Orthod. 2005; 27: 309-14.
14. Liversidge HM, Chaillet N, Mörnstad H, Nyström M, Rowlings K, Taylor J et al. Timing of Demirjian's tooth formation stages. Ann Hum Biol. 2006; 33: 454-70.
15. Qudeimat MA, Behbehani F. Dental age assessment for Kuwaiti children using Demirjian's method. Ann Hum Biol. 2009; 36: 695-704.
16. Wykänen R, Espeland L, Kvaal SI, Krogstad O. Validity of the Demirjian method for dental age estimation when applied to Norwegian children. Acta Odontol Scand. 1998; 56: 238-44.
17. Nicodemo RA, Moraes LC, Médici FE. Tabela cronológica da mineralização dos dentes permanentes entre brasileiros. Rev Fac Odontol São José dos Campos. 1974; 3: 55-6.
18. Landis JR, Koch GG. The measurement of observer agreement for categorical data. Biometrics. 1977; 33: 159-74.
19. Kurita LM, Menezes AV, Casanova MS, Haiter-Neto F. Dental maturity as an indicator of chronological age: radiographic assessment of dental age in a Brazilian population. J Appl Oral Sci. 2007; 15: 99-104.