CHRONOLOGICAL AGE DETERMINATION BASED ON THE ROOT DEVELOPMENT OF A SINGLE THIRD MOLAR: A RETROSPECTIVE STUDY BASED ON 2513 OPGs

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ABSTRACT

The aim of this survey was to correlate chronological age with the root development of only one third molar using a sample of 2513 subjects of Belgian Caucasian origin within the age range of late 15 to 22 years. Observations were performed by two observers, who were calibrated for intra- and inter-rater reliability by means of Kappa statistics and each third molar present was scored according to the modified method of Gleiser and Hunt. The method used in this study delivered linear regression formulae based on a sole wisdom tooth, divided according to gender. The results revealed standard deviations similar to those reported in comparable publications and even to those calculated with other skeletal age calculation techniques. **(J Forensic Odontostomatol 2003;21:31-5)**

Keywords: forensic odontology, dental age calculation, third molar.

INTRODUCTION

In forensic sciences age estimation is not only one of the standard requests upon the discovery of a dead body, but is also crucial if identity is in question in living individuals.[1-3]

Age calculation by means of tooth development and particularly the root formation of third molars has already often proved to be effective in determining an individual's chronological age. Other methods for age calculation using skeletal radiology (hand-wrist, sternoclavicular joints, long bones and vertebrae) or secondary sex characteristics, have at least comparable limitations.[4-9]

The highest accuracy in dental age estimation is achieved when an individual's growth is rapid and many developing teeth are present,[9-13] but between the late teens and early twenties only the developing third molars are useful for age calculation. Although some have argued that their variability in morphology, time of formation and time of eruption[3,14] have unfavourable effects on the age calculation,[3,14-19] it is a fact that this view is based on studies of small samples [3,15-16,18] or case reports.[9,20] In a previous retrospective study the correlation of the chronological age of an individual with the dental development of the third molars was investigated and based on a large sample of orthopantomograms (OPG) taken from individuals with a known chronological age.[21] This led to a series of linear regression formulae, based on the number of wisdom teeth present and their exact location in the upper and lower jaws. On the other hand age calculation of individuals presenting only one third molar often meant a problem because of insufficient numbers and therefore the statistical difficulty of obtaining an appropriate regression formula for this category.

In practice third molars are frequently missing[10,22]: the prevalence of agenesis of one wisdom tooth is reported to be 16% [23] and as the dental practitioner is also often confronted with irregular or malformed crowns, impaction or malposition, which makes dental hygiene difficult, irreversible destruction and loss follows.

Table 1: *Absolute and total number of orthopantomograms in each age category for males and females.*

	15y	16y	17y	18y	19y	20y	21y	22y	23y	Total (n)
Males	20	125	103	146	159	174	219	106	3	1055
Females	33	159	162	191	212	250	308	134	9	1458
Total	53	284	265	337	371	424	527	240	12	2513

y = years n = number

Table 2: *Frequency distribution for males and females of the number of third molars (n) present on all 2513 orthopantomograms evaluated.*

	n	Freq	Total
Males	1	34	34
	2	133	266
	3	141	423
	4	747	2988
Females	1	58	58
	2	180	360
	3	181	543
	4	1039	4156
Totals			8828

Table 3: Some examples of the outcome of the Kappa statistics.

	Weighted κ-value	S.E.	95% LL	95% UL
A1UL by **A2**UL	0,79	0,05	0,70	0,89
A1LR by **A2**LR	0,86	0,04	0,79	0,94
B1UR by **B2**UR	0,65	0,09	0,47	0,83
B1LR by **B2**LR	0,82	0,05	0,72	0,91
A1UL by **B1**UL	0,84	0,05	0,74	0,94
A1LR by **B1**LR	0,87	0,03	0,81	0,94

κ-value: Kappa value
S.E.: Standard Error
LL: Lower limit of the 95% confidence interval
UL: Upper limit of the 95% confidence interval
A1: Observer 1, observation 1
A2: Observer 1, observation 2
B1: Observer 2, observation 1
B2: Observer 2, observation 2
UR: upper right
UL: upper left
LR: lower right
LL: lower left

The aim of this study was to correlate the chronological age with the root development of only one third molar.

MATERIALS AND METHODS

In this study the same material as previously used[21] consisted of a large sample of 2513 OPGs from the School of Dentistry, Oral Pathology and Maxillo-Facial Surgery of the Katholieke Universiteit Leuven, Belgium starting from the early 1970s until early 2002.

All screened subjects were from Belgian Caucasian origin within the age range of late 15 to 22 years with no medical history, showing no obvious dental pathology and having at least one third molar.

The frequency distribution of the number of third molars present on each of the 2513 evaluated OPGs (1055 males, 1458 females) (Table 1) emphasizes the scope of the investigated sample, that is the possibility of studying the developmental stages of 8828 wisdom teeth (Table 2). Given an individual with two wisdom teeth, two separate linear regression formulas could be calculated, for each third molar respectively.

Age calculation was performed using the modified method of Gleiser and Hunt[24] which consists of a 10-stage developmental scale, with three stages for crown formation and seven for root development, previously used by Kohler *et al.* (Fig. 1).[22] All of the third molars were given a score according to their development stage, where the least developed root of a wisdom tooth with multiple roots defined the score.

Two observers were calibrated in advance by scoring 50 OPGs twice with an interval of two weeks, followed by inter- and intra-observer reliability tested using Kappa statistics.

Table 4: *Linear regression formulae for males and females based on the presence of only one wisdom tooth*

	3rd M	R^2	Regression formulae	S.D.	σest
Males	UR	0.38	12,2870+0,8169 UR	1,57	1,59
	UL	0,40	12,2353+0,8231 UL	1,53	1,62
	LL	0,40	13,3669+0,7291 LL	1,53	1,53
	LR	0,38	13,6521+0,6998 LR	1,56	1,56
Females	UR	0,35	13,8062+0,6799 UR	1,60	1,60
	UL	0,35	13,8073+0,6759 UL	1,59	1,59
	LL	0,37	14,2041+0,6639 LL	1,55	1,55
	LR	0,39	14,0809+0,6770 LR	1,54	1,54

3rd M: third molar present
R^2: root square **(linear correlation coefficient)**
S.D.: standard deviation
σ_{est}: standard error of the estimate

$$\sqrt{\frac{\sum(X-X')^2}{N-2}}$$

X': predicted score
X: actual score
N: number of observations

UR: upper right
UL: upper left
LR: lower right
LL: lower left

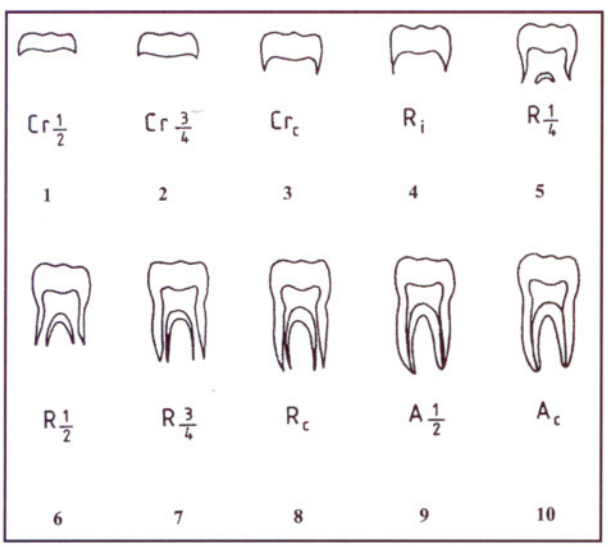

Fig.1: *Development stages according to a modification of the technique by Gleiser and Hunt*[22]

Linear regression analysis was applied in order to obtain linear regression formulae for dental age estimation, with the chronological age as the independent variable and the development stage of only one third molar as the dependent variable, without taking into account the total number of wisdom teeth. This gave four linear regression formulae, one for each of the four third molars.

RESULTS

The Kappa statistics revealed no significant intra- or inter-observer effects (Table 3).

Linear regression analysis led to separate formulae for males and females with the development stage of a sole third molar as the variable (Table 4).

R^2 varied for males from 0,35 to 0,39 and for females from 0,38 to 0,40 and standard deviations for males ranged from 1,53 to 1,57 years, while for females the range was from 1,54 to 1,60 years. The standard error of the estimate ranged for males from 1,53 to1,62 and for females from 1,54 to 1,60 (Table 4).

DISCUSSION

The calculation of these models creates not only the possibility of age estimation of an individual with only one third molar present, but also avoids statistical interference based on multicollinearity between contralateral third molars or antimeres.

The approach of using only one third molar as a variable even though all four can be present has not been encountered in literature. Harris and Nortje[18] had a similar, but not identical method with their measurement of mesial root length of the lower right third molar only and Thorson[3] applied Demirjian's scoring system[11,13] on the lower left third molar, but in cases of agenesis the contralateral was gauged. Other authors,[14,19,22] basing their computations on the presence of four third molars, do not mention the practical consequences when lacking one or more of them, with the exception of Willershausen,[25] whose results are not applicable in the absence of more than one third molar.

Mesotten *et al.*[26] and Gunst *et al.*[21] produced a set of multiple regression formulae from which only the one should be used which applies to the third molar being evaluated. For instance, specially developed multiple regression formulae are reported in cases of the presence of two, three or four third molars. Since high Pearson correlations were found between both upper and both lower third molars, and also, but less so, between antimeres, special measures had to be taken for reasons of multicollinearity.

The weakness of the results was that in cases of the presence of only one third molar , no adequate regression formula could be obtained, because of the relatively small number of individuals in the total sample of the study with only one third molar present. It is now possible to calculate dental age based on a single third molar.

The standard deviations reported in this study have been found to be comparable and approximately equivalent to previous ones[21] and generally in the field of chronological age estimation are very acceptable. The great advantage now is that regression formulae are available for those cases when only one third molar is present, and this is not an infrequent occurrence.

CONCLUSION

The present analysis allowed for the calculation of regression formulae for dental age calculation based on the root development of only one third molar for males and females. Standard errors of the estimate within the range of, respectively, 1,53 to 1,62 and 1,54 to 1,60 were found.

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