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ORIGINAL ARTICLE

The influence of impaction on the rate of third molar mineralisation in male black Africans

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Abstract One of the main criteria used in dental age diagnostics in living adolescents and young adults is assessment of the mineralisation stage of the third molars. In the case of Europid populations, it has been established that impaction status has an influence on the rate of mineralisation of the third molars. In view of this, a study was undertaken to determine whether the chronological process of wisdom tooth mineralisation is dependent upon impaction status in black Africans too. Orthopantomograms (553) of 437 male and 116 female black South Africans with verified birth dates in the age group between 10 and 26 years were studied. Mineralisation stage and impaction status were determined for all third molars. Statistical measures were calculated for the mandibular wisdom teeth at stages F, G and H and for the maxillary wisdom teeth at stage H in the male gender for both impacted and non-impacted third molars. It was ascertained that the minimum age in persons with impacted third molars, depending on the wisdom tooth observed, was 0.19–2.57 years higher than in those with non-impacted wisdom teeth. Test persons with impacted mandibular wisdom teeth at stage F or G were on average between 0.32 and 1.88 years older than those with non-impacted mandibular wisdom teeth. The 50 % probability values of impacted wisdom teeth at stage H were 1.85–3.31 years higher than those in non-impacted wisdom teeth. The conclusion was drawn that in male black Africans, impacted mandibular wisdom teeth mineralise more slowly than non-impacted lower third molars. The presence of impacted mandibular wisdom teeth in mineralisation stage H in male black Africans does not, however, furnish proof of completion of the 18th year of life beyond reasonable doubt.

Keywords Age estimation · Third molar · Mineralisation · Impaction · Black Africans

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Introduction

In recent years, forensic age estimation in living adolescents and young adults of different ethnic origins has become an integral part of forensic practice, justifying a focus of research within the forensic sciences [3,5,7,13,14,16,17,22,27,28,30]. A well-founded age diagnosis can only be achieved with the aid of an interdisciplinary collaboration between forensic medical experts, radiologists and dentists. One crucial precondition which must be met if the relevant expert opinion is to be forensically applicable is attention to the ethnicity and socioeconomic status of the persons examined [26].

Unlike skeletal development which is modulated first and foremost by the socioeconomic status of the population in question [24,25], the chronological sequence of morphological changes in the course of tooth mineralisation is primarily genetically controlled [19]. For dental age diagnostic practice, the use of reference studies specific to the relevant population has been recommended [15].

Impaction status appears to exert an additional influence on the rate of third molar mineralisation. A number of studies have demonstrated that in Europid populations, impacted wisdom teeth display retarded development in comparison with non-impacted third molars, a fact which is of significance for age estimation practice [10,11,18]. In the present study, a black African population was assessed to ascertain the extent to which the presence of an impaction influences the rate of mineralisation of the third molars and thus the point in time when each stage of morphological development is reached.

Material and methods

The study was based on 553 conventionally produced orthopantomograms of 437 male and 116 female black South Africans aged 10–26 years with verified dates of birth. The radiographs came from the X-ray archives of the Department of Oral Pathology and Oral Biology at Pretoria University and were made in the period from 1992 to 2002.

In each case, the identification number, gender and date of birth of the test person, the date of the X-ray examination and the mineralisation stage and impaction status of the existing third molars were recorded. The stage of wisdom tooth mineralisation and the impaction status in each case were determined on a randomised, blinded basis, i.e. with no knowledge of dates of birth or of radiograph dates. Wisdom teeth with mesio- and distoangular or vestibulo-oral angular impaction were considered impacted in accordance with the classifications of Archer [1] and Wolf and Haunfelder [31]. All classifications were determined by one and the same examiner (A. O.). Table 1 shows the number of cases per age cohort of the sample divided by gender.

The following statistical measures were calculated for selected mineralisation stages for impacted and non-impacted third molars separately: minimum age, maximum age, mean with standard deviation as well as the median with upper and lower quartiles. In addition, the 50 % probability values were calculated for the impacted and non-impacted third molars at stage H. To calculate the 50 % probability values, binary logistic regression was used [2]. The programme IBM SPSS STATISTICS 19 was used for the statistical evaluation.

Results

Tables 2 and 3 show the number of cases of impacted and non-impacted third molars for the individual mineralisation stages separated by gender. As there were a total of fewer than ten cases of impacted teeth per stage in the female gender, comparative statistical evaluation was limited to the male gender. Tables 4 and 5 show the statistical measures established for the male test persons, separated by tooth and impaction status, whenever a minimum case number of ten was reached. Table 6 shows the 50 % probability values of impacted and non-impacted third molars at stage H for the male test persons. Statistical measures were calculated for mandibular wisdom teeth at stages F, G and H and for maxillary wisdom teeth at stage H both for impacted and for non-impacted third molars.

Table 1 Age in years and gender distribution of the sample

Age	Male	Female
10	3	2
11	3	3
12	4	4
13	8	4
14	3	4
15	11	5
16	11	12
17	12	6
18	21	7
19	37	6
20	41	13
21	51	9
22	68	13
23	57	13
24	58	7
25	34	6
26	15	2
Total	437	116

In the case of impacted mandibular wisdom teeth, stage F was reached at a minimum age of 13.56 years and on average at an age of 18.74–18.83 years. In impacted mandibular wisdom teeth, stage G was reached at a minimum age of 16.64 or 18.81 years and on average at an age of 21.34 or 22.13 years. Impacted wisdom teeth manifested stage H at a minimum age of 17.57–19.63 years. At an age of 20.63–22.31 years, 50 % of the men studied displayed impacted wisdom teeth at stage H.

In the case of non-impacted mandibular wisdom teeth, stage F was reached at a minimum age of 12.83 years and on average at an age of 18.43–18.48 years. In non-impacted mandibular wisdom teeth, stage G was reached at a minimum age of 15.77 or 17.61 years and on average at an age of 20.25 or 20.73 years. Non-impacted wisdom teeth manifested stage H at a minimum age of 17.06–17.38 years. At an age of 18.78–19.23 years, 50 % of the men studied displayed non-impacted wisdom teeth at stage H.

Taking account of the minimum values, persons with impacted mandibular wisdom teeth at stage F were 0.73 years older than those with non-impacted mandibular

Table 2 Number of cases of impacted and non-impacted third molars at the individual mineralisation stages in males

Stage	18 i.	18 n.-i.	28 i.	28 n.-i.	38 i.	38 n.-i.	48 i.	48 n.-i.
A	0	1	0	1	0	1	0	1
B	1	1	1	1	0	2	0	2
C	0	0	0	0	0	0	0	1
D	0	11	0	13	6	4	6	5
E	1	14	3	11	10	5	5	8
F	1	22	1	26	29	20	29	19
G	3	45	5	42	25	23	29	30
H	12	282	10	288	49	217	48	225

i. impacted, *n.-i.* non-impacted

wisdom teeth. In relation to the point at which stage G was reached, the difference in this respect amounted to 0.57–0.87 years. The minimum age for impacted wisdom teeth at stage H was 0.19–2.57 years higher than that for non-impacted wisdom teeth.

Taking account of the mean values, test persons with impacted mandibular wisdom teeth at stage F, depending on the tooth studied, were between 0.32 and 0.36 years older than those with non-impacted mandibular wisdom teeth. In relation to the point at which stage G was reached, the difference in this respect amounted to 0.80–1.88 years. The 50 % probability values for impacted wisdom teeth at stage H were 1.85–3.31 years higher than those for non-impacted wisdom teeth.

Discussion

Assessment of the mineralisation status of the third molars is a basic component of the spectrum of forensic odontological methods available for age diagnostics in the relevant age group. As far as the authors are aware, only a few studies on the chronological process of wisdom tooth mineralisation in which black Africans with verified dates of birth and living in Africa have been included are available [15,20,21]. Olze et al. [15] have established statistical measures for the male black South Africans studied in relation to the point at which each stage according to Demirjian et al. [6] is reached. The male test persons reached stage F at the age of 18.7 and stage G at the age of 20.8 years. At an age of 20.0 years, 50 % of the black men studied manifested impacted wisdom teeth at stage H. The corresponding mean values for stages F–H were 18.7, 20.6 and 22.8 years, respectively. Phillips and van Wyk Kotze [20] have determined statistical measures for black African Nguni peoples (male and female Zulu and Xhosa) using the stage classification developed by Moorrees et al. [12]. Due to the choice of age groups (5–17 years), the highest stage that could be determined was stage $R_{3/4}$. The median values for stages $R_{1/2}/R_{3/4}$ (corresponds approximately to stage F according to Demirjian) ranged from 15.46 to 15.78 years.

Furthermore, studies in which reference data on the process of wisdom tooth mineralisation in black North Americans have been determined are available [4,8]. Blankenship et al. [4] determined statistical measures for black US Americans aged 14–24 years in relation to the point at which they reach stages D–G according to Demirjian. The median values for the male test persons for stages F and G were 16.61 and 17.85 years, respectively. Harris [8] determined statistical measures for black US Americans aged 3–25 years using the stage classification of Moorrees et al. [12]. On average, the male test persons reached stages $R_{1/2}/R_{3/4}$ at the age of 15.82–16.78 years and stages $R_c/A_{1/2}$ (corresponds approximately to stage H according to Demirjian) at the age of 17.82–18.53 years. At an age of 20.61 years, 50 % of the male black US Americans manifested impacted wisdom teeth at stage A_c (corresponds approximately to stage H according to Demirjian). The corresponding median values

Table 3 Number of cases of impacted and non-impacted third molars at the individual mineralisation stages in females

Stage	18 i.	18 n.-i.	28 i.	28 n.-i.	38 i.	38 n.-i.	48 i.	48 n.-i.
A	0	0	0	0	0	0	0	0
B	0	0	0	0	0	0	0	0
C	0	1	0	2	1	1	3	1
D	1	10	1	11	5	7	4	6
E	1	16	0	15	8	5	8	6
F	1	4	0	3	4	11	6	8
G	1	14	0	13	7	7	5	10
H	1	56	2	61	5	46	6	42

i. impacted, *n.-i.* non-impacted

Table 4 Statistical measures in years for non-impacted third molars at the individual mineralisation stages in males

Tooth	Stage	Case number	Min	Max	Mean	SD	LQ	Median	UQ
18	D	11	10.29	15.72	13.21	1.49	12.14	13.05	14.13
	E	14	13.07	19.73	15.57	2.04	13.67	15.09	17.03
	F	22	12.83	23.09	17.86	2.34	16.46	17.37	19.35
	G	45	15.57	26.73	20.95	2.62	18.82	21.00	22.94
	H	282	17.06	26.95	22.68	2.15	21.27	22.78	24.31
28	D	13	10.29	15.20	13.39	1.47	12.42	13.34	14.80
	E	11	12.14	18.46	14.94	2.06	13.52	14.17	16.80
	F	26	12.83	23.09	17.92	2.43	16.36	17.66	19.57
	G	42	15.57	26.73	20.49	2.59	18.52	20.44	22.54
	H	288	17.38	26.95	22.76	2.12	21.27	22.87	24.36
38	F	20	12.83	21.86	18.43	2.35	16.63	18.21	20.54
	G	23	17.61	25.17	20.73	2.10	19.14	20.10	22.49
	H	217	17.38	26.95	22.80	2.02	21.32	22.88	24.32
48	F	19	12.83	23.43	18.48	2.54	16.74	18.39	20.37
	G	30	15.77	24.88	20.25	2.17	18.53	20.00	21.74
	H	225	17.38	26.91	22.91	1.96	21.39	23.12	24.41

Min minimum, *Max* maximum, *SD* standard deviation, *LQ* lower quartile, *UQ* upper quartile

for stages F and G were 15.88–16.90 and 17.62–18.63 years, respectively. The extent to which the reference values determined by the said authors can be applied to black Africans is not clear as black and white North Americans originate from overlapping gene pools [23].

A number of studies have been devoted to the influence of impaction on the rate of third molar mineralisation in Europids [10,11,18]. As a result, the authors cited agreed in their conclusion that impacted third molars in Europid populations mineralise more slowly than non-impacted wisdom teeth. Knell and Schmeling [10] were able to determine a developmental delay of 0.6–0.7 years, depending on gender, for impacted third molars at stage H according to Demirjian, as compared with non-impacted wisdom teeth at the final stage of mineralisation. All those examined with two impacted mandibular wisdom teeth at stage H were older than 18 years. Similarly, in the study by Olze et al. [18], with the exception of female test persons with impacted left lower wisdom teeth (minimum age, 17.84 years), all those examined with impacted third molars at stage H were older than 18 years.

The authors of the present study considered the question of the extent to which the chronological process of wisdom tooth mineralisation in black Africans is similarly dependent upon impaction status. Statistical measures were determined in relation to the point at which mineralisation stages F–H according to Demirjian were reached for impacted and non-impacted mandibular wisdom teeth as well as stage H for maxillary wisdom teeth in male black South Africans with verified dates of birth.

It was ascertained that the minimum age in persons with impacted mandibular wisdom teeth at stage F was 0.73 years higher than in those with non-impacted mandibular wisdom teeth. In relation to the age at which stage G was reached, the difference in this respect was 0.57–0.87 years. The minimum age for impacted wisdom teeth at stage H was 0.19–2.57 years higher than that for non-impacted wisdom teeth. Taking account of the mean values, test persons with

Table 5 Statistical measures in years for impacted third molars at the individual mineralisation stages in males

Tooth	Stage	Case number	Min	Max	Mean	SD	LQ	Median	UQ
18	H	12	19.63	25.26	22.48	2.04	20.34	22.50	24.31
28	H	10	17.61	25.22	21.42	2.21	19.95	21.09	22.79
38	E	10	12.14	21.11	16.08	2.87	13.40	15.64	18.13
	F	29	13.56	23.09	18.74	2.56	16.86	19.03	20.50
	G	25	18.18	25.61	21.34	2.36	19.08	21.33	23.28
	H	49	17.57	26.78	22.90	2.30	22.32	22.87	24.46
48	F	29	13.56	23.09	18.83	2.15	17.28	18.98	20.14
	G	29	16.64	26.73	22.13	2.37	20.38	22.47	23.55
	H	48	17.57	26.78	22.84	2.07	21.96	22.73	24.23

Min minimum, *Max* maximum, *SD* standard deviation, *LQ* lower quartile, *UQ* upper quartile

Table 6 Data on 50 % probability values in years for impacted and non-impacted third molars at stage H in males

Tooth	Impaction status	50 % probability value
18	Impacted	20.63
18	Non-impacted	18.78
28	Impacted	22.25
28	Non-impacted	18.94
38	Impacted	21.92
38	Non-impacted	18.93
48	Impacted	22.31
48	Non-impacted	19.23

impacted mandibular wisdom teeth at stage F, depending on the tooth studied, were between 0.32 and 0.36 years older than those with non-impacted mandibular wisdom teeth. With regard to the point at which stage G was reached, the difference in this respect was 0.80–1.88 years. As the mean values of the final stage of a characteristic depend on the upper age limit of the sample studied [9], the 50 % probability values for stage H were also calculated. The 50 % probability values of impacted wisdom teeth at stage H were 1.85–3.31 years higher than those of non-impacted wisdom teeth.

A limitation of the present study is the relatively small number of cases, particularly in relation to females and the early stages of mineralisation in males. This means that a comparative statistical analysis of the influence of impaction on the rate of third molar mineralisation could only be carried out for higher mineralisation stages in males. However, male black Africans with third molars at higher stages of mineralisation are the group particularly relevant to age estimation practice. Moreover, as far as the authors are aware, this is the only study on this question carried out so far on black Africans with verified dates of birth. To this day, the registration of births, particularly in the sub-Saharan African countries, remains a problem which should not be underestimated. Whilst in the so-called industrialised nations throughout the world, 98 % of births are registered, and in North Africa and the Middle East, for example, 84 % are registered, the proportion in this regard in the sub-Saharan region amounts to a mere 45 % [29].

The following conclusions relevant to age estimation practice may be drawn from the results of the present study:

1. Impacted mandibular wisdom teeth in male black Africans mineralise more slowly than non-impacted lower third molars.
2. In the case of male black Africans, the presence of impacted mandibular wisdom teeth at mineralisation stage H does not provide evidence of completion of the 18th year of life beyond reasonable doubt.

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