DENTAL AGE PREDICTION USING THE RADIOGRAPHIC VISIBILITY OF ROOT PULP OF LOWER THIRD MOLARS AMONG SELECTED NIGERIANS.

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ABSTRACT

BACKGROUND: There is an increasing need for a scientifically proven method to determine an individual's age beyond a reasonable doubt, which has necessitated the use of several methods to confirm human age. One of the methods used in age estimation among humans is the assessment of dental radiographs, which can be used in conjunction with other methods.

OBJECTIVE: To evaluate the usefulness of orthopantomogram (OPG) in age estimation among selected Nigerians.

METHODS: A retrospective assessment of 306 orthopantomograms from the Department of Oral Pathology at University College Hospital, Ibadan, Nigeria, was undertaken. The inclusion criteria included an image that was clear enough for a reasonable diagnosis, showing third molars with complete root formation and apical closure, and the availability of complete biodata for the patient. The included OPGs were assessed for the radiographic visibility of the root pulp canals of mandibular third molars, as described by Olze et al. The age estimations using the radiographic visibility of the root pulp canals were then compared with their chronologic age.

RESULTS: Three hundred and six OPGs were assessed, comprising those belonging to 139 (45.4%) males and 167 (54.6%) females, with their ages ranging from 16 to 40 years. An assessment of the minimum age of the stages of radiographic visibility of the root pulp revealed that the minimum age at which the lumen of all root canals is visible to the apex (stage 0) was 16 years for both genders, as observed in teeth 38 and 48. Apart from stage 1 in tooth 48, which had a higher minimum age than stage 2, there was a gradual increase in the minimum age from stage 0 to 3. However, the trend for maximum age was a sharp transition from 36 to 40 years for both teeth from stage 1 to 3.

CONCLUSION: Within the limitations of this study, OPG images of mandibular third molars can be used to reasonably estimate the age of individuals, as found in this study, and may also be useful in differentiating Nigerians with an earlier eruption sequence from Caucasians with reported delayed eruption of third mandibular molars.

KEYWORDS: Pulp visibility, Age prediction, Orthopanthomogram, Mandibular molars

INTRODUCTION

Forensic age estimation is a crucial aspect of forensic investigations. When traditional methods of identification, such as birth records or government-issued identification, are not available, dental age prediction or estimation becomes a valuable tool for determining the age of an individual. Reasons for the correct prediction of an individual's age are increasing with the growing conflict and security challenges worldwide, resulting in mass casualties that may require the identification of affected individuals and the desire for migration to other countries by survivors[1,2]. The United Nations Convention on the Rights of the Child confers special rights to children under the age of 18, which increases the possibility of such individuals being granted asylum in their desired country. Some desperate migrants are taking advantage of this by falsifying their age, leaving foreign authorities in doubt as to their actual age, with the need for scientifically proven means of confirming the age of affected individuals becoming more necessary[1]. Confirmation of age is also relevant in the dispensation of criminal justice, as those younger than 18 years are considered minors, and juvenile penal law applies in such cases rather than adult penal law. In the political scene, the right to vote and be voted for is also based on the age of individuals, with the possibility of some politicians employing underage voters to boost their chances of winning an election. Much debate is going on concerning child marriage, abuse, and sexual molestation, and it may require correct age estimation that is scientifically proven to convict an offender in a law court[5-7]. Teeth, being highly calcified, stand a good chance of surviving adverse conditions such as extreme temperatures, fire accidents, and attempts to destroy evidence of criminal activities. Some dental materials used for replacing or restoring teeth have also been reported to be able to withstand such adverse conditions compared to human tissues[6,8,9]. With the recovery of the dental remnants, there will be a need to identify the true source of the remnant, which requires identifying the affected individual. The usefulness of forensic odontology in civil and criminal justice systems cannot be overstated; therefore, the need for further study in this area is evident[10-14].

For an equitable and just conclusion, there should be a scientifically proven method for determining whether someone is under 18 years of age or not. Age, being a major factor in determining an individual's identity, can be estimated through scientific methods such as radiographic assessment of the jaws, hands, wrists, or medial clavicular epiphyses.[2] For age estimation, radiographic landmarks that had been used include but are not limited to an assessment of jaw bones prenatally, appearance of tooth germs, earliest detectable trace of mineralization or beginning of mineralization, degree of crown completion, the eruption of the crown into the oral cavity, degree of root completion of erupted or unerupted teeth, degree of resorption of deciduous teeth, measurement of open apices, co-existence of deciduous and permanent dentition, the volume of pulp chamber and root canals/formation of physiologic secondary dentine, tooth-to-pulp ratio, third molar development and topography. Pulp and root length, pulp and tooth length, tooth and root length, and pulp and root width can also be compared in assessing for age estimation[10,11,13-16]. Radiologic assessment of age estimation has the advantage of being useful for both living and deceased

individuals, with the possibility of comparing ante- and post-mortem records, which is not feasible with histological and biochemical methods. Histological and biochemical methods are more appropriate for dead individuals as they may require sectioning of the tooth[10-11]. Dental radiographs are relatively inexpensive, readily accessible, and can be rapidly obtained with less exposure to radiation compared to other forms of radiographs. Dental radiographs can also be used to complement other methods of age estimation, thereby improving the accuracy of prediction[10-13].

The difficulty in confirming that an individual is older than 18 years persists, despite various published works, and it is considered even more challenging to confirm that an individual is older than 21 years. Many studies are concentrating on the physiological development of third molars to resolve the issue3-7. Radiographic visibility of the pulp canals of fully erupted third molars may offer the necessary solution. This method involves examining the root pulp canal of the third molars, commonly known as the wisdom teeth. By analyzing the visibility of the root pulp in these teeth and combining it with other factors to establish age charts, forensic experts may be able to estimate an individual's age with a relatively high level of accuracy[4]. Therefore, the authors undertook this study to evaluate the radiographic visibility of pulp canals in third molars, intending to correlate the stage of development with the stage classification for age estimation as described by Olze et al. [4]

MATERIALS AND METHODS

Three hundred and six orthopantomograms (OPGs) in the Department of Oral Pathology, University College Hospital, Ibadan, Nigeria that were clear enough for a reasonable diagnosis to be made showed third molars with completed root formation and closed apices. These OPGs were retrospectively reviewed in this study. All images were acquired using a Planmeca digital OPG machine with Romexis software viewer version 19.2. The images included in the study were from routine investigations conducted between 2019 and 2024. Images with any bony lesion, such as an osteolytic lesion or fracture, and those showing carious lesions involving the lower second or third molars were excluded. The included OPGs were assessed for the radiographic visibility of the pulp chamber of lower third molars, as described by Olze et al.[4] Olze et al. described stage 0 of pulp chamber visibility as the lumen of all root canals being visible to the apex.

In contrast, the lumen of one root canal is not fully visible to the apex in stage 1. The lumens of two root canals are not fully visible to the apex, or one canal may be virtually invisible to full length in stage 2, and the lumen of two root canals is virtually invisible to full length in stage 3 (Figure 1)[4]. Assessment of the OPGs was done by a standardized examiner (OF) after an initial repeated assessment of ten images that were not included in the subsequent study. The results of the repeated assessment were subjected to Cohen's Kappa test, yielding a result of 0.89. Ethical approval was obtained from the UI/UCH ethics review committee prior to the commencement of the study.

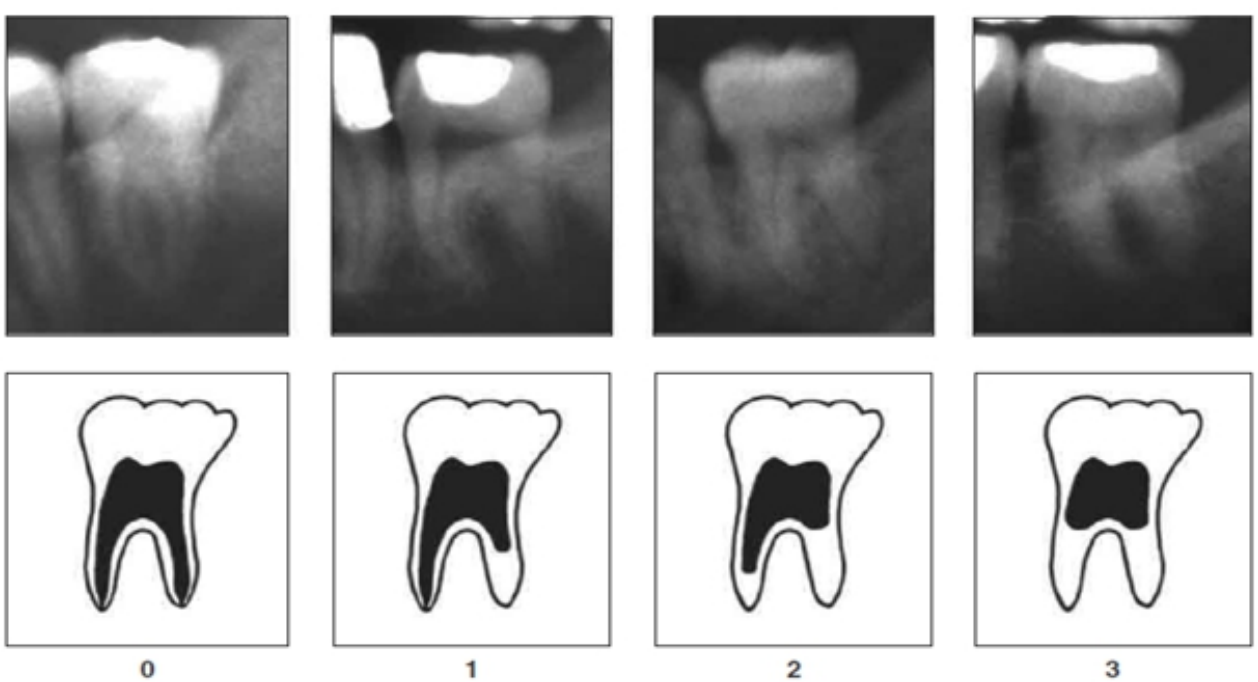

Fig. 1: Schematic diagram and radiographs of stages of radiographic visibility of the root pulp in the lower third molars (Adapted from Olze et al., 20104).

Case note number, sex, date of birth, date of radiographic exposure, and the stage of radiographic visibility of the roots were recorded for each of the OPGs. The dates of birth and exposure were not known to the examiner to avoid bias. Individual ages were then calculated by deducting the date of exposure from the date of birth, which was recorded in years. A minimum and maximum age, median age with lower and upper quartiles, and mean age with standard deviation were calculated for each group. The calculated age was then compared with the known chronologic age of the owners of the assessed OPG.

Data management and analysis

The data collected was collated, computed, and subjected to statistical analysis using SPSS Version 22. Qualitative variables were summarized by frequencies, percentages and proportions, and quantitative variables were summarized by means, standard deviations and confidence intervals.

RESULTS

A total of 306 OPGs were assessed comprising of that which belong to 139 (45.4%) males and 167 (54.6%) females with their age ranging from 16 to 40 years. A larger percentage of the OPGs belong to individuals within the age range 16 to 28 years (Table 1).

Table 1: Age and sex distribution of respondents

Age	Male	Female	Total (%)
16	7	4	11 (3.6)
17	10	9	19 (6.2)
18	7	14	21 (6.9)
19	7	5	12 (3.9)
20	5	11	16 (5.2)
21	4	4	8 (2.6)
22	9	13	22 (7.2)
23	5	10	15 (4.9)
24	11	18	29 (9.5)
25	4	8	12 (3.9)
26	4	10	14 (4.6)
27	4	11	15 (4.9)
28	3	9	12 (3.9)
29	2	4	6 (2.0)
30	1	6	7 (2.3)
31	5	2	7 (2.3)
32	5	3	8 (2.6)
33	3	5	8 (2.6)
34	8	2	10 (3.3)
35	3	1	4 (1.3)
36	9	5	14 (4.6)
37	6	4	10 (3.3)
38	4	4	8 (2.6)
39	7	4	11 (3.6)
40	6	1	7 (2.3)
Total	**139**	**167**	**306**

An assessment of the minimum age at which the stages of radiographic visibility of the root pulp appeared revealed that the minimum age for stage 0 was 16 years for both teeth (tooth numbers 38 and 48). In the two mandibular third molars, the minimum age at which each of the stages appeared gradually increased from stage 0 to 3 except for stage 1 in tooth 48, which was higher than that of stage 2. The trend for maximum age was an increase from 36 years to 40 years for both teeth from stage 1 to 3. The mean and median age show the same trend of gradual increase from stage 0 to 3 (Table 2).

Table 2: Age in years of the stages of radiographic visibility of the root pulp of teeth numbers 38 and 48 in subjects

Tooth	Stage	Number	Min	Max	LQ	Median	UQ	Mean	SD
38	0	140	16.00	36.00	24.00	20.00	18.00	20.99	3.75
	1	108	17.00	40.00	34.00	29.00	24.25	29.31	5.65
	2	47	18.00	40.00	38.00	34.00	27.00	32.30	6.42
	3	11	27.00	40.00	39.00	36.00	32.00	35.45	4.34
48	0	157	16.00	36.00	24.00	21.00	18.00	21.43	4.17
	1	79	20.00	40.00	34.00	27.00	25.00	29.13	5.33
	2	52	18.00	40.00	37.00	34.00	28.25	32.73	5.71
	3	18	28.00	40.00	39.00	37.00	31.75	35.78	4.10

Min – minimum age, Max – maximum age, SD – standard deviation, LQ – lower quartile, UQ – upper quartile.

When the effect of gender difference was considered, there was a gradual increase in the minimum age for both teeth numbers 38 and 48 among males—however, the discrepancy in stage 1 appearing later than stage 2 affected females. For maximum age, the trend for males was closely related to that seen when the whole group was considered together for tooth 38, while a slight difference was seen with tooth 48 (Table 3).

However, for females, the trend for tooth 38 first increased steadily till stage 2 and then declined for stage 3. The mean and median age followed a similar trend for both males and females, with a steady increase as the stages increased.

Table 3: Age in years of the stages of radiographic visibility of the root pulp of teeth numbers 38 and 48 in male subjects

Tooth	Stage	Number	Min	Max	LQ	Median	UQ	Mean	SD
38	0	54	16.00	28.00	22.25	19.00	17.00	19.96	3.29
	1	52	17.00	40.00	35.75	31.50	24.25	30.31	5.91
	2	26	21.00	40.00	39.00	35.50	28.75	33.58	6.05
	3	7	32.00	40.00	40.00	38.00	36.00	37.29	2.87
48	0	60	16.00	36.00	23.00	19.00	17.00	20.78	4.72
	1	37	20.00	38.00	34.00	29.00	24.00	29.27	5.38
	2	26	21.00	40.00	38.25	35.35	30.75	33.81	5.56
	3	16	28.00	40.00	39.00	37.50	33.00	36.19	3.97

Min – minimum age, Max – maximum age, SD – standard deviation, LQ – lower quartile, UQ – upper quartile.

Table 4: Age in years of the stages of radiographic visibility of the root pulp of teeth 38 and 48 in female subjects

Tooth	Stage	Number	Min	Max	LQ	Median	UQ	Mean	SD
38	0	86	16.00	36.00	24.00	22.00	18.00	21.63	3.90
	1	56	17.00	39.00	32.75	27.00	24.25	28.38	5.28
	2	21	18.00	40.00	37.00	30.00	25.50	30.71	6.66
	3	4	27.00	37.00	26.75	32.50	27.50	32.25	4.99
48	0	97	16.00	31.00	24.00	22.00	18.00	21.82	3.76
	1	42	20.00	40.00	33.00	27.00	25.00	29.00	5.35
	2	26	18.00	39.00	37.00	32.50	26.75	31.65	5.76
	3	2	29.00	36.00	32.50	32.50	29.00	32.50	4.95

Min – minimum age, Max – maximum age, SD – standard deviation, LQ – lower quartile, UQ – upper quartile.

DISCUSSION

The OPGs analysed in this study were those of 306 individuals consisting of 139 (45.4%) males and 167 (54.6%) females. Ethical issues bordering on exposure to radiation preclude a prospective assessment of routine dental patients. Therefore, a retrospective assessment of the OPGs was conducted to evaluate the pulp visibility of the right and left mandibular third molars and to compare the estimated age of the individuals with their biological age. Maxillary third molars were excluded due to the possibility of anatomic structures that may superimpose on the third molars in the region.

The results of this study revealed that the minimum age for stage 0 in both males and females was 16 years. The fact that stage 0 of the radiographic visibility of the root pulp was observed among 16-year-olds may suggest that anyone with stage 0 of the radiographic pulp visibility will be at least 16 years old, which was observed across the two mandibular third molars in both males and females. This may go a long way in confirming this age group among people of interest and exclude other ages, as the minimum age for other stages of root pulp visibility was higher than 16 years. This minimum age was lower than that reported by Olze et al., who reported 17.2 years for females and 17.6 years for males.[4] This finding could be associated with the reported earlier maturation of third molars among Blacks compared with their Caucasian counterparts, among whom Olze et al. did their work17-22. Our findings also contrasted with those of Olze et al.[4], in that the two mandibular third molars had the same minimum age for stage 0 among both males and females, whereas Olze et al. reported an earlier attainment of the stage by females. The authors can only presume that this difference also could be due to genetic variation between the two different ethnic groups. This similarity between males and females suggests that OPGs may not be useful in differentiating between males and females in our population, which requires further studies to confirm.

Other stages of maturity in root pulp visibility tend to increase from the lowest stage to the highest, indicating that the higher the stage of root pulp visibility, the older an individual is likely to be. However, there is one notable deviation from this trend, which occurs between stages 1 and 2 among females. In this case, the minimum age for stage 2 was lower than that of stage 1 for tooth number 48. This reveals early maturation variation in females compared to males in this study, in contrast to previous studies that reported earlier development in males for the third molars.[23,24] The differences between these studies and ours could be attributed to racial differences, as our study was conducted among Africans, while the others were among Caucasians.

The maximum age for root pulp canal visibility in stage 0 for the two mandibular molars was 28 and 36 years for males and 31 and 36 years for females. The disappearance of the root pulp canal has been linked to the lifelong deposition of secondary dentine in individuals, which gradually narrows the pulp canals with age. It does not necessarily mean that the root pulp is completely obliterated, despite the fact that it is no longer clearly visible on the radiographs. However, it is considered an optical phenomenon, in which case the narrowing of the canal prevents visualization of the canals. Olze et al.[4] posited that if there had been a sufficient number of individuals older than 50 years of age, the maximum age would have been appreciably increased, but not the minimum age.

CONCLUSION

Within the limitations of this study, OPG images of mandibular third molars can be used to reasonably estimate an individual's age, as found in this study. They may also be useful in differentiating Nigerians with an earlier eruption sequence from Caucasians with reported delayed eruption of third mandibular molars.

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