Development Stages of Third-Molar Tooth for Estimation of Chronological Age in Children and Young Adult

AMIR AMANULLAH, USMAN ULLAH, SARAH YUNUS, *ABDUL MUNIM**

ABSTRACT

Aim: To evaluate judgment of chronologic age based on the stages of third-molar growth following the eight stages (A-H) technique of Demirjian et al and to compare third-molar development by age and sex with outcome of previous studies.

Methods: The study was conducted in Dental Unit D.H.Q, Teaching Hospital affiliated with Gomal Medical College, D.I.Khan. The final sample consisted of 300 orthopantomograms from young Pakistani population of known chronologic age (range, 9-26 years; mean age, 15.94±3.72 years) and sex (130 males with a mean age of 15.53±3.75; 170 females with a mean age of 16.36±3.89). The Mann-Whitney U-test and the Wilcoxon test were applied for statistical analysis between sex and age. Regression analysis was performed to obtain regression formulas for dental age calculation with the chronologic age

Results: In third-molar growth between males and females were showed about the calcification stages D and G ($P<0.05$, statistically significant differences). The genesis of third-molar was attained earlier in males than in females. A strong correlation was showed between age and third-molar growth for males ($r^2=0.64$) and for females ($r^2=0.60$). Equations (Age=9.42±1.60 Development stage) were derived for chronologic age estimation.

Conclusion: The third-molars is a appropriate developmental marker, particularly when comparing the obtained standard deviation with other skeletal age calculation methods.

Keywords: Third molar; chronological age; Pakistani; age judgment

INTRODUCTION

Teeth are the most resistant part and having the least turnover of natural structure and used reliably in age estimation. They are relatively unchanged for a long time and also survive death[1]. In various studies, the third molars are the main variable in the dentition of teeth, the most reliable biologic tool for estimation of age during early twenties[2]. The third molar tooth is significantly important and reliable tool for age determination in juveniles or adults when no other official document is available. In addition, this form of age assessment can be applied in patient suffering from amnesia and also specimens of anthropological or forensic importance[3].

To determine age in people within the range of 15.5-23.5 years remains a problem. Skeletal markers, including hand-wrist assessment, fusion of epiphysis and diaphysis, cervical vertebrae judgment, changes in the pubic symphysis, amino acid racemization, sternoclavicular bones, fusion of cranial sutures, or changes in secondary sex characteristics. The above variables especially during these years

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Department of Anatomy, Gomal Medical College, Dera Ismail Khan., Pakistan
*Department of Anatomy, Khyber Medical University, Peshawar, Pakistan
Correspondence to Dr. Amir Amanullah, Associate Professor, E Mail: amiramanullahkhan@yahoo.com   Cell 03219011023

are more or less uncertain to determine age and have their advantages and disadvantages[4,5]

The representation of teeth useful is material for assessment of age. Highly accurate age is assessed by observing dentition stages in infants. However, this accuracy reduces as a person's dental growth is completed[6]. The morphologic assessment of radiologic and skeletal features of third molars in juveniles are two methods of age estimation[7].

The third molar has a unique characteristics as it continues to grow for a longer period as compared with other teeth. But third molars are the most variable of all teeth[8] However, it seems to be a reliable method for assessing the age of unreported juvenile individuals or asylum seekers when compared with the other skeletal maturity indicators in combination.

A number of research have been carried out in different regions to look at the efficacy of the third molar as a suitable age marker[6,10-11]. Those studies revealed that dental growth between different populations show a little variations, suggesting population-specific studies are essential. Near to present, for various racial groups, several studies are there on the assessment of development of third-molar.[6,10-11] At the beginning of this study, we hypothesized that in Pakistani children development of third molar tooth might have a different tempo than

that of the standards obtained from children of other countries. Therefore, third molar development was regarded as a useful tool to determine the developmental stages in a Pakistani young population, to estimate chronologic age on the basis of developmental stages, to compare growth of third-molar tooth growth by sex and age, and these findings were also compared with other studies.

Table 1. Demirjian et al Criteria for stages of tooth calcification[9]

Stage	
A	Single occlusal points calcified with no union of various calcifications.
B	Union of mineralization areas; recognizable margins of the occlusal surface.
C	Complete formation of enemal at the occlusal surface, and dentine appearence started. Curved pulp chamber with pulp horns not seen.
D	Complete development of Crown upto the amelocemental margin. Beginning of root development. Differentiation of the pulp horns begins, but the pulp chamber walls remain curved.
E	The crown height is more than length of the root. The pulp chamber walls are straight, and more differentiation of the pulp horns than in the previous stage. The radicular bifurcation begins to calcify in molars.
F	Isosceles triangle formation by the walls of the pulp chamber now and the crown height is equal to or lesser than the root length. Distinct form of roots due to sufficient bifurcation.
G	The apical end is open partially and root canal walls are parallel now. In molars only the distal root is rated.
H	Uniform width of the periodontal membrane surrounding the apex and root. Complete closure of the root apex (distal root in molars).

METHODOLOGY

This cross-sectional study was conducted in Dental Unit D.H.Q, Teaching Hospital affiliated with Gomal Medical College, D.I.Khan. The 300 orthopantomograms of Pakistani subjects with known chronologic age and sex were selected. All well nourished, healthy with good dental hygiene and normal growth i.e., congenital absence, no impactions, or transposition of teeth were included in the study. Patients with image deformity and Orthopantomogram showing clear dental pathology were excluded. Eleven films were not included for low radiographic quality, and 61 films for agenesis of the third molar were excluded. The final sample containing 300 orthopantomograms from Pakistani subjects of known chronologic age and sex. In the study the mean age of the 300 patients were 15.94±3.72 years with a range of 9 to 26 years; 130 male with the mean age of 15.53±3.75 years and 170 were female with the mean age of 16.36±3.89 years. All evaluations were carried out in a dark room with

an illuminator to increase contrast of the tooth images. Left third mandibular molar was considered if not present than contralateral tooth was used to assess the development phase by examination and classification.

The method described by Demirjian et al[9] was used for tooth calcification, in which one of eight stages (A to H) of calcification was assigned to the third-molar tooth (Table 1). The crown formation from the beginning of calcification of cusp to complete calcification of crown as shown by the first four stages (A-D). The root formation from initial radicular bifurcation to apical closing as indicated by the last four stages (E-H).

The range of the chronologic ages with means and standard deviations were obtained for the eight developmental stages. The Wilcoxon and Mann-Whitney U-test were used for statistical analysis between age and sex. Regression analysis was performed for dental age to obtain regression formulas. The chronologic age is used as an independent variable and third- molar developmental stages as dependent variables. SPSS 17 for analysis was used.

Two investigators randomly reassessed the radiographs from ten percent of the same female and male subjects after eight weeks of first evaluation for assessing the reproducibility of dental development stage. Wilcoxon matched-pairs signed-rank test was used to determine Intra-and inter-observer agreements.

RESULTS

Thirty radiographs (repeated scorings of a subsample) showing no significant difference of interobserver or intraobserver (P>0.05). The consistency in interobserver was 94% and intraobserver was 97%.

The development process of third molar in both sexes was observed, and the ages with mean and standard deviations for the Demirjian stages are showing in Table 2 and illustrated in Figure 1. In third-molar growth between males and females about the calcification stage D and stage G were revealed significant differences statistically (P<0.05). That finding revealed that the Demirjian stages commenced earlier in males than in females. In addition B and F stages in males show a minor delay but statistically not significant.

The useful landmarks such as stage D crown completion, stage G root-length completion, and stage H apical closure were defined for population in tooth development. The findings of the individuals by age with formation stages (percentile distributions) are given in Figure 1. In present study, stage D,

females (around 74%) and males (89%) were ≤14.5 years old. In stage G, males (approximately 68%) and females (58%) were between 17 and 20 years old. In stage H, males (around 69%) and females (78%) were >22 years old. Before the age of 17 years, formation of third-molar teeth was completed in only three subjects (two females and one male).

Chronologic age and third molar growth correlation is evaluated by Linear regression coefficients. Statistically firm correlation was found between the third molar growth and age for females (r^2=0.60) and for males (r^2=0.64). Regression formulas for males and females individually and complete sample were estimated on the basis of the number of third molar teeth. The new equations are derived in the present study:

Males: Age=8.73±1.49 Development stage
Females: Age = 9.70±1.55 Development stage
Whole sample: Age=9.2±1.60 Development stage

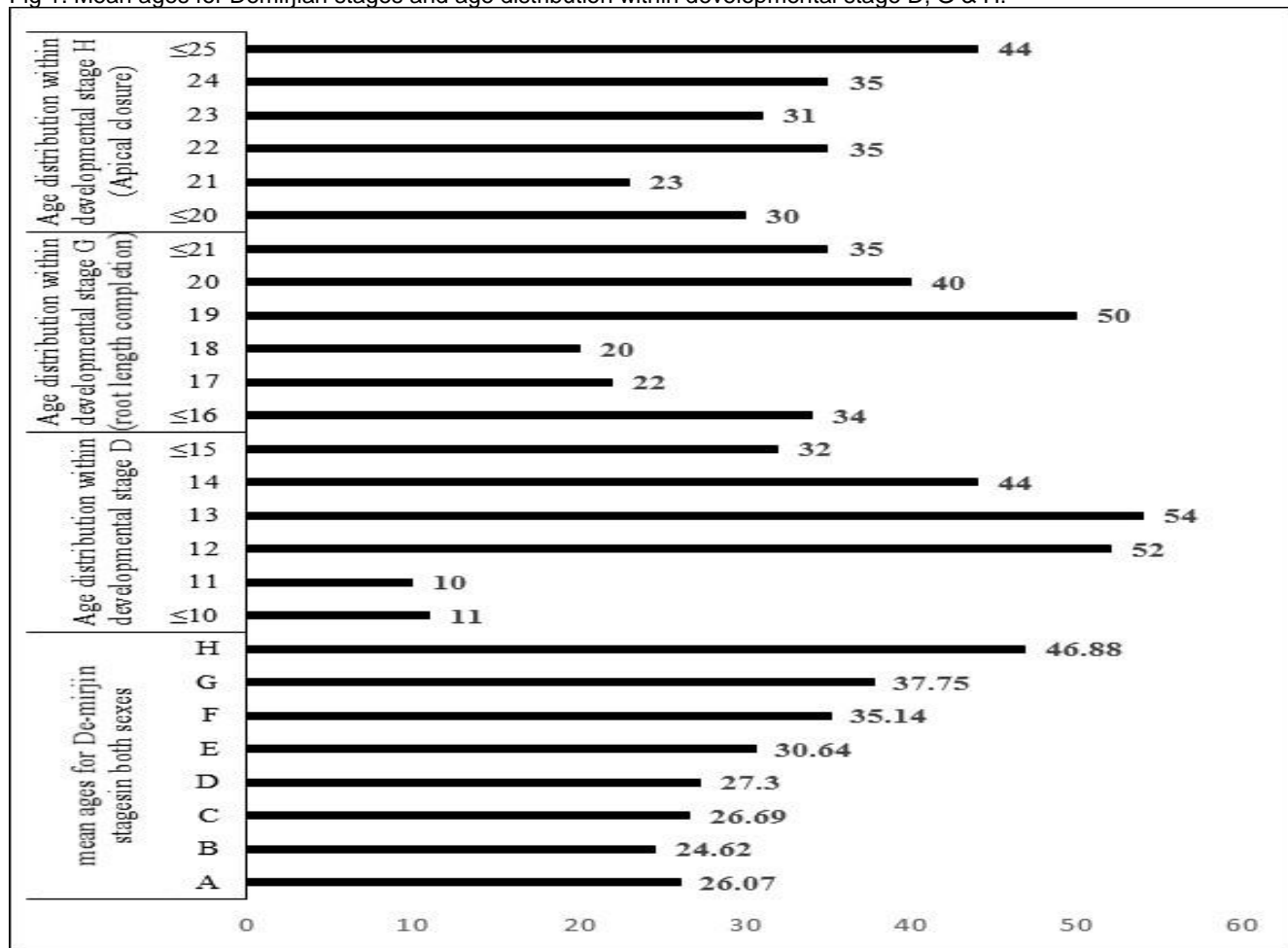Fig 1. Mean ages for Demirjian stages and age distribution within developmental stage D, G & H.

Table 2: Descriptive values and statistical comparisons of Demirjian stages in males and females

Demirjian Stage	Male			Female			Test
	N	Mean	SD	N	Mean	SD	P value
Stage A	24	12.43	3.48	33	13.64	4.45	NS
Stage B	23	12.3	2.42	22	12.32	2.52	NS
Stage C	20	13.12	1.75	19	13.57	1.73	NS
Stage D	13	13.4	1.5	24	13.9	2.52	*
Stage E	10	14.32	1.8	12	16.32	2.3	NS
Stage F	8	17.6	1.4	11	17.54	1.9	NS
Stage G	10	18.06	2.42	15	19.69	2.42	*
Stage H	22	23.02	2.9	34	23.86	2.16	NS

SD indicates standard deviation   NS indicates not significant   * P<0.05.

Table 3. Showing details of different populations with mean age and standard deviation in years based on Demirjian's Criteria.

Stage	Gender	Japanese (Prieto et al[11])		South African (Olze et al[10])		Turkish (Olze et al[10])		German (Olze et al[10])		Spanish	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
D	Male	15.08	1.04	15.08	1.04	18.2	3.3	16.3	3.1	13.4	1.5
	Female	15.11	1.00	15.11	1.00	18.0	2.8	15.5	2.6	13.9	2.52
E	Male	15.22	1.03	15.2	2.4	18.5	2.7	16.7	2.3	14.32	1.8
	Female	16.00	1.43	15.9	2.3	18.6	2.3	16.8	2.3	16.32	2.3
F	Male	16.42	1.34	18.7	2.3	20.4	2.4	18.3	2.2	17.6	1.4
	Female	16.83	1.56	21.3	2.5	20.5	2.2	19.1	2.5	17.54	1.9
G	Male	17.92	1.50	20.8	2.2	21.8	2.5	20.6	2.4	18.06	2.42
	Female	18.41	1.44	19.8	2.3	21.8	2.0	21.7	2.1	19.69	2.2
H	Male	19.74	1.09	22.6	1.9	22.7	2.0	22.7	1.9	23.02	2.9
	Female	19.66	0.98	22.4	1.9	22.4	2.1	23.0	1.8	23.86	2.16

SD indicates standard deviation.

DISCUSSION

The tooth development for estimation of chronologic age has been used since long time. Chronologic age is accurately measured by assessment of third molar tooth, not influenced by external factors such as any disease or malnurished state[6,12]. When growth is nearing completion, age can be accurately assessed by the third molar calcification stage.[5] The age estimates based on dental methods have short falls, in particular during teenage years when only the third molar is lasting variable. Certainly, a large variation in morphology and time of development and position exists.

In the current study, to overcome some of these shortcomings, all participants were of Pakistani origin, and all 300 orthopantomograms were evaluated by two well-reputed examiners using eight stages according to the Demirjian et al criteria[9].

The minimum age limit in the present study was 8 years similar as two international studies done by Uzamis et al[13] and Orhan et al[14]. In the mandibular arch, the crypt was visible as early as 8 years.

The studies in the past, sex differences showed different results, we examined the each stage for male and female individuals for a Pakistani individuals by mean ages. Stage D and G for calcification stages in third molar tooth showed statistically significant differences between female and male individuals. These significant differences showed that third-molar formation occurs later in females than males according to Demirjian stages. These findings were in accordance with other researchers, which report that the developmental stages commenced later in females than for males in the following populations Swedes,[15] Belgian whites,[16] Hispanics,[6] or people of Spanish origin[11]. However, some researchers have find out distributions for both sexes and similar mean age values[17,18].

Orhan et al[14] determined that the reaches stage H at a mean age of 20.1 years. Our observations revealed that the reaches stage H with a mean age of 23.02 years in males and 23.86 years in females. This is not in agreement with the results of other research works. The miscellany may be due to differences in the selected age range of the study population with other studies. Results showing the probability of an individual being younger than 17 years (at stages D and E) or older than 19 years (at stage H) are in accordance with previous studies.[11,15,17] In Pakistani population development of third molar takes place earlier than in German,[17,19] South African[10] and Japanese[20] populations for all stages when compared with our results (Table 3). It is only for stages F, G, and H that third-molar development occurs earlier in the Spanish[11].

Mean absolute difference between chronologic age and dental age have been observed with high accuracy. The third molar growth stage with the age of the individual has a nearly linear relation, irrespective of female or male; the latter develops a little earlier as reported.[16,21] Statistical analysis showed a stronger correlation for female ($r^2 = 0.60$) than for male ($r^2 = 0.64$) subjects. These results also have the same opinion with studies on other populations.[11]

CONCLUSIONS

1. Third-molar growth among the Pakistani population occurs at an recent age for almost all stages than in other populations. Only in stages F, G, and H does third-molar growth take place earlier in Spanish[11] than in Pakistani subjects.
2. Third molars are used as a suitable growth indicator, when especially derived standard deviation compared with other methods for skeletal age estimation based on long bones or wrist-hand, for example.

3. To determine age with increased accuracy, sexual maturity indications and ossification should also be derived in addition to third-molar mineralization.

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