Original Research Paper

Age Determination in Manipuri Subjects from the Eruption of Teeth and Epiphyseal Union of Upper Limb

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Abstract

The present study aims to determine the age of the Manipuri population by computing regression formulae from the eruption of the permanent canine & second molar, and also from the epiphyseal union at the elbow and wrist joints. 320 Manipuri subjects of 10 to 15 years (i.e. 244 male, 76 female) coming to the Forensic Medicine department of a tertiary health care hospital at Imphal for age determination from October 2011 to September 2013 were studied. The age of eruption of permanent canines is 10 years in both sexes; whereas the eruption of second permanent molar is 11-12 years in females and 11-14 years in males in the Manipuri population. The medial epicondyle fuses with the shaft of humerus in 11-14 years in both the sexes. The epiphyseal fusions of 1st metacarpal take place in 13 -15 years in females and 12-14 years in males. A combined regression formula was calculated for males and females. It can be used as a standard for determination of age in Manipuri subjects by substituting the various stages of dental eruption or epiphyseal union.

Key Words: Canine, Second Molar, Epiphyseal Union, Regression Formulae

Introduction:

Age estimation in living as well as dead is one of the most important tasks for a forensic practitioner. In a developing country like India, illiteracy is a major factor for un-awareness regarding importance of registration of births or improper maintenance of records.

It is a prerequisite for personal identification and it is increasingly important in criminal and civil matters. [1] The notion of the age and time had come into the mind of the human being for centuries, possibly millennia.

In this universe, most of the things, natural or artificial can be dated, numbered, quantified or measured. One can also measure life span of a person as well as one's age from the moment of conception. India is a very vast country with diversity of climate and population. Hence, no uniform data can be applied to the whole country. [2]

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There are three steps for age estimation:

1. Physical examination
2. Dental examination and
3. Radiological examination

Various workers have established data for estimation of age from dental and radiological findings in different ethics groups. [3-5]

However, no such data is available for the Manipuri population. Hence, this study has been taken up in a tertiary health care teaching hospital at Imphal.

Materials and Methods:

After obtaining approval of the Institutional Ethics Committee, 320 Manipuri subjects in the age group of 10-15 years (i.e. 244 male, 76 female) coming to the Forensic Medicine department of a tertiary health care teaching hospital at Imphal for age determination from October 2011 to September 2013 have been included for the study.

Criteria for Selection of the Cases:

1. Subject must be a Manipuri by birth.
2. Subject must be of sound health with no dental caries, cavity or any chronic illness which might interfere with the eruption of tooth and fusion of bone.
3. Age of the subject should be verified by parents and birth certificates.

The particulars with relevant information of each case were recorded in a separate proforma. The informed consent was taken in written form and the general physical

examination was done to detect any disease or deformity which may affect the fusion of the epiphyses and eruption of tooth.

The oral cavity was examined with the help of a torch light and a dental mirror by widely opening the mouth with a tongue depressor. A detailed dental examination was done with special emphasis on the eruption of permanent canine and second permanent molar.

The same subject was subjected to X-ray of elbow and both wrist joints (AP view) to know the degree of fusion in the lower end of humerus and metacarpal bones.

The radiographs were studied jointly with the radiologists. The stages of eruption of tooth were graded as follows:

- **Stage 0**: Fall out of the temporary tooth and non-eruption of corresponding permanent tooth.
- **Stage 1**: When tip of crown of tooth penetrated the gum margin (positive clinical eruption).
- **Stage 2**: When the crown has grown into oral cavity beyond gum margins but not yet reached the occlusal plane.
- **Stage 3**: When the colossal surface comes in contact with its counterpart and bite is complete. [6]

The degrees of fusion of the various epiphyses with their respective diaphysis were graded as:

- **Degree 0**: A dark radiolucent line throughout the joint separating the joint surfaces.
- **Degree 1**: The area of fusion (radio opaque area) is seen in the middle or on either side of the joining surfaces. The measured length of the radio opaque area should be less than half of the total length of the epiphyseal surface.
- **Degree 2**: The area of fusion (radio opaque area) should be more than half of the total length of the epiphyseal surface but it has not completely covered the entire length.
- **Degree 3**: Complete fusion (radio opaque area) is seen in the entire length of the joining surface. [7]

For this study, following sites were examined in the upper limb viz. trochlea, lateral epicondyle, medial epicondyle, 1st to 5th metacarpal. The findings were recorded in the respective proforma, tabulated and statistically analysed by using SPSS 16 software.

Observations and Results:

In the present study, out of the total 320 cases, 76.25% of the cases were males and 23.75% were females. Meitei with 245(76.56%) cases were the maximum cases examined with respect to caste followed by Manipuri Tribal with 58(18.12%) cases and Manipuri Muslim with 17(5.32%) cases. (Table 1)

It is evident from this study that the age of eruption of permanent canines is 10 years both males and females; whereas the eruption of second permanent molar is 11- 12 years in females and 11-14 years in males. (Table 2)

The fusion of trochlea to the capitulum takes place in 11-12 years in females and 12 -13 years in males; whereas the fusion of lateral epicondyle to capitulum occurs in 11-14 years in females and 12-14 years in males.

The medial epicondyle fuses with the shaft of humerus in 11 to 14 years in both the sexes. The epiphyseal fusions of 1st metacarpal take place in 13-15 years in females and 12-14 years in males. (Table 3)

In this study, a suitable regression formula for computing the age of an individual from the eruption of tooth and degree of epiphyseal union was calculated. The formulae for each variable were derived separately and combined formulae were also derived.

The combined formulae may be used when all the variables are present and regression formulae for the individual if only one variable is examined.

The combined equation has the advantage of being more accurate as it is evident from the standard error, which is least and also there is maximum positive correlation. Separate equations were derived for both females and males. (Table 4, 5)

Finally, after calculating the age for each individual by using the regression formulae for both males and females, it is compared with the known age (age from birth certificates).

It is observed that in females, the mean difference between the age as per the birth certificate and calculated age by the regression formulae is -0.8947, which is less than 1.

There is also positive correlation of 0.702 between the two sets of data and the standard deviation is 1.06557. (Table 6)

Similar findings are observed in males and there is positive correlation of 0.631 between the two sets of data, and the standard deviation is 0.99945. (Table 7)

Discussion:

There was not much difference between the times of eruption of the canine and the second molar teeth with respect to sex in the Manipuri population in the present study. Similarly, Shuper A et al [8] found similar number of erupted teeth in both sexes in a study on the Jewish Israeli children for deciduous tooth

eruption. However, workers like Hagg U and Taranger J [9] and Savera BS and Steen JC [10] found that eruption is generally earlier in girls.

This earlier eruption might be due to earlier age of puberty in females with earlier associated secretion of growth hormone which may affect the tooth eruption in the studied population.

Gaulstaun G [11] also studied 7000 X-rays of Bengali subjects and found that fusion of trochlea, lateral epicondyle, and medial epicondyle take place at 10-12 yrs, 10-12 yrs, 14 years in females and 11-16yrs, 11-16yrs and 16 years in males respectively.

These findings may be favourably compared with findings of the present study. However, these findings are in contrast with those of Borosvansky L and Hnevkovsky L, [12] and Sahni D and Jit L [13] who observed later fusion of the epiphyses as compared to the present study.

Various workers like Jaswant AD et al [14], Rai B and Anand SC [15] have presented certain regression formulae for their respective regions. In this part of the country too, some workers like Sangma WB et al [16] and Bijoy Th et al [17] had earlier presented regression formulae by using the staging of epiphyseal union of the long bones alone.

In our study, we derived regression formulae using both the stages of dental eruption and epiphyseal union and found that the age of an individual has a positive correlation with these two variables.

The standard error is the minimum when we combined both the above variables and also the positive correlation is the maximum when all these variables are used to derive the formulae.

The timing of dental eruption and epiphyseal union are influenced by many factors, which include diet, geographical location, race, sex, etc.

According to Swami D et al [18] The eruption of teeth is known to be affected by dietary, climatic, racial and geographical variations and according to Krogman WM, [19] the time of the appearance of ossification centres and their union are also influenced by the factors like sex, nutrition, and deficiency of vitamin D, calcium and hormones released from the anterior pituitary, thyroid and parathyroid glands.

This imposes the need for deriving certain formulae for the estimation of age in this part of the country which has a unique diet and demography. In this study, an attempt has been made to calculate a separate formula for both female and male for the Manipuri population.

Using the derived regression formulae, it was found to be almost matching with the known age, with positive correlation between the two.

Conclusion:

There is positive correlation between eruption of teeth and epiphyseal union of bone with the chronological age of an individual.

This regression formula can be used as a standard for determination of age in Manipuri subjects by substituting the various stages of dental eruption or epiphyseal union in the derived formulae, which is a simple and more accurate way of estimating the age than the usual method of age determination by using the data of other country or states.

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Table 1

Distribution of Cases With Respect to Sex and Caste in Different Age Groups

Age Group (Yrs)	Sex		Caste		
	Male	Female	Meitei	M. Tribal	M. Muslim
10 ≤ to <11	22 (9.02)	5 (6.58)	21(8.57)	4 (6.89)	2 (11.76)
11 ≤ to <12	16 (6.56)	4 (5.26)	18(7.35)	0	2 (11.76)
12≤ to < 13	69 (28.28)	**24 (31.58)**	**83(33.88)**	8 (13.80)	2 (11.76)
13≤ to <14	**76 (31.14)**	22 (28.94)	72(29.39)	**21(36.21)**	**5 (29.42)**
14≤ to <15	48 (19.67)	15 (19.75)	44(17.96)	15(25.86)	4 (23.42)
15≤ to <16	13 (5.33)	6 (7.89)	7 (2.85)	10 (17.24)	2 (11.76)
SUB. TOTAL	244 (100)	76 (100)	245 (100)	58 (100)	17 (100)
TOTAL	**244 (76.25)**+ 76(23.75) = 320 (100)		**245 (76.56)** + 58 (18.12) + 17 (5.32) =320 (100)		

Table 2

Minimum &Maximum Age of Different Stages of Eruption in Permanent Canine and Second Molar

Degree of Eruption	Canine(Years)				2nd Molar (Years)			
STAGE	Female		Male		Female		Male	
	Min	Max	Min	Max	Min	Max	Min	Max
0	10	12	10	14	10	13	10	13
1	**10**	**10**	**10**	**10**	**11**	**12**	**11**	**14**
2	0	0	10	11	0	0	11	14
3	11	15	10	15	12	15	10	15

Table 3

Minimum & Maximum Age of Epiphyseal Fusion in the Lower End of Humerus and Metacarpals

Degree of Fusion	Trochlea(Yrs)		Lat. Epicondyle (Yrs)		Med Epicondyle (Yrs)		1stmetacarpal (Yrs)		2nd,3rd,4th,5th Metacarpal (Yrs)	
	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male
0	10-13	10-15	10-13	10-15	10-13	10-15	10-14	10-15	10-13	10-15
1	0	**12-13**	0	**12-14**	**11**	**11-14**	0	**12-13**	**13-14**	**12-15**
2	**11-12**	11-13	**11-14**	11-14	**12-14**	**12-14**	**13-15**	**12-14**	**12-15**	**12-15**
3	12-15	11-15	12-15	11-15	12-15	11-15	12-15	11-15	12-15	11-15

Table 4

Different Statistical Results of Manipuri Male (10 to 15yrs)

Variables	Coefficient of Correlation	Regression Equation	Standard Error
Canine	.392	$Y = (.746)\ X_1 + 10.513$	± 1.176
2nd MOLAR	.601	$Y = (.699)\ X_2 + 10.912$	±1.022
Trochlea	.535	$Y = (.477)\ X_3 + 11.772$	±1.080
Lat. Epicondyle	.531	$Y = (.475)\ X_4 + 11.866$	±1.083
Med. Epicondyle	.459	$Y = (.434)\ X_5 + 12.188$	±1.136
1st Metacarpal	.409	$Y = (.401)\ X_6 + 12.279$	±1.167
2,3,4,5 Metacarpal	.386	$Y = (.401)\ X_7 + 12.312$	±1.179
Combined	.677	$Y_M = (.155)\mathbf{X_1} + (.453)\mathbf{X_2} + (.137)\mathbf{X_3} + (.044)\mathbf{X_4} + (.149)\mathbf{X_5} + (.163)\mathbf{X_6} (.149)\mathbf{X_7} + 10.588$	**±.952**

Table 5

Different Statistical Results of Manipuri Female (10 to 15yrs)

Variables	Coefficient Of Correlation	Regression Equation	Standard Error
Canine	.577	$Y = (.902)\ X_1 + 10.284$	± 1.052
2nd MOLAR	.632	$Y = (.672)\ X_2 + 11.162$	±.9639
Trochlea	.639	$Y = (.639)\ X_3 + 11.299$	±.9676
Lat. Epicondyle	.652	$Y = (.635)\ X_4 + 11.392$	±.9582
Med Epicondyle	.636	$Y = (.590)\ X_5 + 11.661$	±.9546
1st Metacarpal	.629	$Y = (.546)\ X_6 + 11.995$	±.9733
2,3,4,5 Metacarpal	.675	$Y = (.617)\ X_7 + 11.943$	±.9219
COMBINED	.816	$Y_F = (.370)\mathbf{X_1} + (.270)\mathbf{X_2} + (.45)\mathbf{X_3} + (.162)\mathbf{X_4} - (.042)\mathbf{X_5} - (.506)\mathbf{X_6} + (.9)\mathbf{X_7} + 10.396$	**±.76108**

$\mathbf{X_1}$=Stage of eruption of permanent canine.$\mathbf{X_2}$=Stage of eruption of 2nd permanent molar.

$\mathbf{X_3}$=Degree of epiphyseal fusion of trochlea$\mathbf{X_4}$=Degree of epiphyseal fusion of lateral epicondyle.

$\mathbf{X_5}$=Degree of epiphyseal fusion of medial epicondyle.$\mathbf{X_6}$=Degree of epiphyseal fusion of 1st Metacarpal.

$\mathbf{X_7}$=Degree of epiphyseal fusion of 2nd, 3rd, 4th and 5th Metacarpal. $\mathbf{Y_M}$= Calculated age of the male individual.

$\mathbf{Y_F}$=Calculated age of the female individual.

Table 6
Mean Difference between the given Age and the calculated age by the Regression Formula (Females)

Paired sample Statistic(Female)							
	N	Mean	Mean Difference	Correlation Coefficient	Standard deviation	Standard deviation	Standard Error
Age(certificates)	76	12.7632	-0.8947	0.762	1.25293	1.06557	0.14372
Age(calculated)	76	13.6579			1.64562		0.18877

Table 7
Mean Difference between the given Age and the calculated age by the Regression Formula (males)

Paired sample Statistic(Male)							
	N	Mean	Mean Difference	Correlation coefficient	Standard deviation	Standard deviation	Standard Error
Age(certificates)	244	12.62	0.2593	0.631	1.276	0.99945	0.082
Age(calculated)	244	12.3607			0.94773		0.06067

Corrigendum

We are regreted for publication of Research Paper entitled ***"Age Estimation from Sternum for Age Group 25 Years On wards"*** *in J Indian Acad Forensic Med.* ***October-December 2014, Vol. 36, No. 4 and in*** *J Indian Acad Forensic Med.* ***July-September 2014, Vol. 36, No. 3 two times.***

Due to error in communication and typing names of some co-authors was missed in this paper. The names of Authors may kindly be read on page No. 340 in fourth issue in the published manuscript as follows:

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