**ORIGINAL RESEARCH** 

# Estimation of Skeletal maturity in Vidarbha Region by Regression formula from Radiological Study around Wrist Joint

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#### ABSTRACT

**Background:** Estimation of Age from skeletal maturity by radiological study of epiphyseal fusion of bones is subject of wide importance specially in medicolegal cases. In present study Regression formula was derived from epiphyseal fusion around lower end of Radius and Ulna and then observed age from radiographs and estimated age from regression formula was compared. **Material and Method:** Anteroposterior view Radiographs of Wrist joint of total 107 subjects taken, there were 54 males and 53 females for assessing radiological age. Regression formula was derived for lower end of Radius and Ulna from stages of epiphyseal fusion. Observed age and estimated age from regression formula are derived and compared. **Result:** Found no significant difference in Observed age and estimated age from regression formula. **Conclusion:** Derivation of regression formula for epiphyseal fusion is easy and simple but accurate way for estimation of Skeletal maturity. **Key Words:** lower end of Radius and Ulna, radiograph, epiphyseal fusion, regression formula

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## INTRODUCTION

Skeletal age refers to degree of development of ossification of bone. Assessment of skeletal age is an important task for Anatomist and Forensic experts in developing countries like India where still there is unawareness regarding birth registration in some regions and also improper maintainance of records. So, if doubt arises regarding age in medicolegal cases forensic age estimation is requested bv authorities .After puberty the process of growth in length of the long bones stops at different ages in different parts of different long bones. This stoppage of growth process is indicative on x-ray examination by fusion of the epiphysis with its respective diaphysis, or can say secondary centre with primary centre. Further, it is found that the age for the fusions is fairly constant with minor variations among different study groups of different geographic areas. The minor differences in the age of fusion could be due to effects of changes in climate, economic, hereditary, dietetic conditions or involving some

unknown factors. According to Aggrwal MI & Pathak IC (1957)<sup>1</sup>, epiphysis of bones unites during particular age periods which are remarkably constant for a particular epiphysis. This fact is of great medicolegal importance and serves as a very reliable evidence for determination of age of a person.

Lots of work has been done on age estimation in different parts of India as well as abroad but very few studies have worked on regression formula for estimation of age from radiographs.All studies observed that age of epiphyseal fusion is different in different region that leads to need of separate standards for separate region. Therefore present work is carried out with an attempt to assess skeletal age in Vidarbha region by using regression formula from radiological study around Wrist joint.

### MATERIAL AND METHOD

Total 107 subjects examined, there were 54 males and 53 females. Accurate age, as far as possible, was determined in each case based on the statements of the

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subjects, supported by their school leaving certificates and prospective observational study was carried out. For statistical analysis, the subjects were divided into eight groups as 13, 14,15, 16, 17, 18, 19, 20 years according to their mean ages. The subjects of age ranging from 12years 6 months to 13years 5months were included in the mean age group 13years and cases of age 13years 6months to 14years 5months taken into age group 14years and so on upto 20years.

Radiographs of the Left Elbow and Wrist joints were taken in Antero-Posterior view at the Department of Radiodiagnosis at our Institute of Government Medical College.

The following epiphyses were examined:

- 1. Lower end of radius
- 2. Lower end of Ulna.

Staging of the degree of fusion of the epiphysis around the Wrist joint was done according to **Prasad RS et al**<sup>2</sup>and were considered as criteria for union.

**Degree 0:** A dark radioluscent line seen throughout the length of the epiphyseal and metaphyseal joining surfaces (Union not yet commenced).

**Degree1:** Radio-opaque area is seen in the middle or on either side of the epiphyseal and metaphyseal joining surfaces (Union commenced).

**Degree 2:** Radio-opaque area is more than half of the epiphyseal and metaphyseal joining surfaces (Union incomplete).

**Degree 3:** Radio-opaque area is seen in the entire length of the epiphyseal and metaphyseal joining surfaces (Union complete).

cases belonging to native population of Vidarbha region of India were included in the study.

#### **Exclusion criteria**

The length of residence of subject in Vidarbha region less than 10 years and the cases showing detectable gross defect or history of any musculo-skeletal or metabolic disorder or endocrinal disorder that affecting the bone development were excluded from the present study.

#### Statistical analysis

Statistical data was recorded on Microsoft Excel programme. All the parameters were presented as mean  $\pm$  standard deviation. Categorical variables (age, sex) were expressed in actual numbers and percentages. Categorical variables were compared by performing Chi square test. Linear regression analysis was used to estimate age by independant variable( degree of union).Paired t-test was performed to compare Observed and estimated age. The 'p' value (p< 0.05) was considered as statistically significant. Statistical software STATA version 10.0 was used for statistical analysis.

Stastical equation used in this study is as follows:

y = a + b x

where,

y-age (dependant variable)

a – constant

b – Regression coefficient

x – Degree of union (independant variable)

This equation suggests that 1 unit change in X value will lead to change in Y value by 'b' times where 'a' was coefficient constant.

#### **Inclusion criteria**

Normal healthy individuals whose exact date of birth was known were included in the study and only the

### RESULT

AGES OF UNION OF EPIPHYSES AROUND WRIST JOINT IN MALES AND FEMALES Table No. I showing age of union of the Lower end of Radius with shaft

Mean Age	Sov	Total no.of	Degree of Union							
In years	Sex	cases	Degree 0	%	Degree 1	%	Degree 2	%	Degree 3	%
12	F	4	0	0	0	0	4	100	0	0
15	Μ	3	0	0	0	0	3	100	0	0
14	F	4	0	0	0	0	4	100	0	0
14	Μ	6	0	0	0	0	6	100	0	0
15	F	6	0	0	0	0	6	100	0	0
15	Μ	7	0	0	0	0	7	100	0	0
16	F	5	0	0	0	0	5	100	0	0
10	Μ	2	0	0	0	0	2	100	0	0
17	F	6	0	0	0	0	2	33	4	67
17	Μ	5	0	0	0	0	5	100	0	0
19	F	11	0	0	0	0	0	0	11	100
10	Μ	12	0	0	0	0	3	25	9	75
10	F	9	0	0	0	0	0	0	9	100
19	Μ	9	0	0	0	0	0	0	9	100
20	F	8	0	0	0	0	0	0	8	100
20	М	10	0	0	0	0	0	0	10	100

Above Table the shows youngest age group with complete union of lower end of Radius with shaft in 100% subjects is 18 years in case of Females and 19 years in case of Males.

Mean Age	Sov	Total no.of				Degree	of Union			
In years	Sex	cases	Degree 0	%	Degree 1	%	Degree 2	%	Degree 3	%
12	F	4	0	0	0	0	4	100	0	0
13	М	3	0	0	0	0	3	100	0	0
14	F	4	0	0	0	0	4	100	0	0
14	М	6	0	0	0	0	6	100	0	0
15	F	6	0	0	0	0	6	100	0	0
15	М	7	0	0	0	0	7	100	0	0
16	F	5	0	0	0	0	5	100	0	0
10	М	2	0	0	0	0	2	100	0	0
17	F	6	0	0	0	0	2	33	4	67
17	М	5	0	0	0	0	5	100	0	0
19	F	11	0	0	0	0	0	0	11	100
10	М	12	0	0	0	0	3	25	9	75
10	F	9	0	0	0	0	0	0	9	100
19	М	9	0	0	0	0	0	0	9	100
20	F	8	0	0	0	0	0	0	8	100
20	М	10	0	0	0	0	0	0	10	100

#### Table No. II showing age of union of the Lower end of Ulna with shaft

Above Table shows youngest age group with complete union of lower end of Radius with shaft in 100% subjects is 18 years in case of Females and 19 years in case of Males.

#### REGRESSION FORMULAE AT WRIST JOINT IN CASE OF MALES AND FEMALES.

Table no.III Regression equations and Standard errors for LEOR and LEOU in case of Males and Females.

Joint studied	Epiphysis studied	Regression Equation (Male)	S.E. (Male)	Regression Equation (Female)	S.E. (Female)
Wrist joint	Lower end of radius (LEOR) /	y=7.9670+3.6896(X1)	0.34	y=7.2589+3.7991(X1)	0.31
Wrist joint	Lower end of Ulna (LEOU)	y=7.9670+3.6896(X2)	0.34	y=7.2589+3.7991(X2)	0.31

(As observations for Degrees of union at Lower end of radius and Lower end of Ulna are found to be same so for stastical analysis we consider as one parameter )

From above table we can estimate age of an individual with following regression equation :

For Males: Age=7.9670+3.6896(X1 or X2) with S.E. - 0.34

For Females: Age=7.2589+3.7991(X1 or X2) with S.E.- 0.31

# Table no. IV showing Observed Age and Estimated age from Regression Formulae derived for Wrist joint in case of males.

	Observed age	Estimated age LEOR / LEOU
Mean	17.25	17.07
SD	2.24	2.01
SEM	0.30	0.27
CV%	12.98	11.8
Т		1.08
p val	0.2850 NS	

From above table it is seen that there is nonsignificant difference in Observed Age and Estimated age from Regression Formulae derived for Wrist joint from Degrees of union at Lower end of radius (LEOR) / Lower end of Ulna(LEOU) in case of males.

# Table no. V showing Observed Age and Estimated age from Regression Formulae derived for Wrist joint in case of Females

	Observed Age	Estimated age LEOR / LEOU
Mean	17.15	17.41
SD	2.17	1.97

SEM	0.29	0.27
CV%	12.7	11.3
	Т	1.7293
	p value	0.0897 NS

From above table it is seen that there is non significant difference in Observed Age and Estimated age from Regression Formulae derived for Wrist joint from Degrees of union at Lower end of radius (LEOR) / Lower end of Ulna(LEOU) in case of females

#### DISCUSSION

Epiphyseal fusion of lower end of Ulna with shaft occurs 1-2 years earlier in Punjabis, North-West Indian females, Bengalis and Mumbai region and it is almost similar in Delhi region, Manipuri girls, North-East Indian girls, Ahemadabad population and South Indians and Madhya pradesh population but 1-2 years later in Uttar pradesh population and Vidarbha region (Nemade KS 2010<sup>10</sup>) as compared to present study of Vidarbha region. Table no.VI

Similar difference also found in age of epiphyseal fusion as compared to studies in other countries as per Table no.VII

W Sangma (2007)<sup>3</sup> studied North-East indian females and **BijoySingh** (2007)<sup>4</sup> studied Manipuri females and derived Regression equation and standard errors from epiphyseal union around Elbow and Wrist joint for estimation of age.(Table noVIII) In the Present study Regression equations are derived for Wrist joint.From these Regression equations age is estimated which shows non-significant difference in Observed age and Estimated age for Wrist joint in both males and females.Coefficient of Variation is same for both lower end of Radius and lower end of Ulna.Thus, age can be estimated more accurately by individual epiphysis of lower end of Radius and lower end of Ulna in both males and females.

Finally, present study supports the view of majority of the workers all over the world that the ages of epiphyseal union vary greatly throughout the world and standards for one region or one race can not be applied to others and that is why there is need of separate standards of epiphyseal union for separate regions as suggested by Loder et. al (1993)<sup>5</sup> and Koc et al (2001)<sup>6</sup>.Use of regression formula will lead to simple yet accurate estimation of skeletal maturity from radiological study around Wrist joint

Table No. VIShowing comparison of ages (years) of union of epiphyses around Wrist joint given by various workers in India with findings of present study

Author	Lower end	l of Radius	Lower end of Ulna		
Autior	Male	Female	Male	Female	
Aggrawal ML and Pathak IC <sup>1</sup> 1957 (Punjab)	-	17-17.6	-	17-17.6	
Banerjee KK and Agarwal BB <sup>7</sup> 1998(Delhi)	19-20	18-19	19-20	18-19	
DasGupta et al <sup>8</sup> 1974(U.P.)	20-21	19-20	20-21	20-21	
Singh B <sup>4</sup> 2007 (Manipur)	-	18	-	18	
Sangma WB <sup>3</sup> 2007 (North-east India)	-	18	-	18	
Sahni D and Jit I <sup>9</sup> 1995 (Northwest India)	-	16	-	16	
Saksena JS and Vyas SK <sup>10</sup> 1969(M.P.)	19-20	17-18	19-20	17-18	
Patel DS <sup>11</sup> 2011(Ahemadabad)	19-20	19-20	19-20	18-19	
Bhise SS <sup>12</sup> 2011(Mumbai)	17-18	17-18	17-18	16-17	
Nemade KS <sup>13</sup> 2010(Vidarbha, M.S.)	20-21	19-20	19-20	19-20	
Dresent study (Videnha, M.S.)	19	18	19	18	
Present study (Vidarona, M.S.)	(18.6-19.5)	(17.6-18.5)	(18.6-19.5)	(17.6-18.5)	

Table No.VII Showing	comparison o	f ages (y	years) of	union of	epiphyses	around	Wrist	joint	given	by
various workers in Othe	er countries wi	th findin	igs of pres	sent study	7					

Author	Lower end	l of Radius	Lower end of Ulna		
Autior	Male	Female	Male	Female	
Paterson RS <sup>14</sup> 1929(English)	21	19-20	21	19-20	
Sidhom G and Derry DE <sup>15</sup> 1931 (Egypt)	19-20	-	19-20	-	
Barrett JH <sup>16</sup> 1936 (Burma)	-	17-18	-	17-18	
Ledger LK and Wasson TC <sup>17</sup> 1941 (Peshawar)	20	18-19	18-19	16-17	
Flecker H <sup>18</sup> 1932 (Australia)	19	18	19	17.5	
Present study	19	18	19	18	
(Vidarbha, M.S.)	(18.6-19.5)	(17.6-18.5)	(18.6-19.5)	(17.6-18.5)	

Author	Joint studied	Regression Equation (Male)	S.E. (Male)	Regression Equation (Female)	S.E. (Female)
Sangma WB <sup>3</sup> 2007 (NorthEast India)	Wrist joint	-	-	11.58+1.9(X)	1.73
Singh B <sup>4</sup> 2007 (Manipur)	Wrist joint	-	-	Yc=18+(0)X	+/- 0.37
Present study (Vidarbha, M.S.)	Wrist joint	y=7.9670+3.6896(x4)	0.34	y=7.2589+3.7991 (x4)	0.31

Table No. VIII Showing comparison of Regression equation for Wrist joint given by various workers.

# DEGREES OF EPIPHYSEAL UNION AT WRIST JOINT



(a)- Degree 0 of epiphyseal union



(c)- Degree 2 of epiphyseal union

#### CONCLUSION

It is concluded that

- 1. Radiograph of Wrist joint (lower end of Radius & Ulna) can be used for age estimation in age group 13-20 years
- 2. Regression formula can be used to estimate age and is simple but accurate way for it.
- 3. Need of separate regression formula for each region so age can be estimated in easy and simple way.

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(b)- Degree 1 of epiphyseal union



(d)- Degree 3 of epiphyseal union

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