

# The Age Order of Epiphyseal Union around Elbow Joint - A Radiological Study in Vidarbha

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## Research Article

**Abstract:** Age of union of epiphysis is an important objective method of age determination which is a difficult task for medico-legal person. However, this age varies with racial, geographic, climatic and various other factors. Study of various text books in Anatomy and Radiology exhibits a glaring discrepancy as regards the ages at which the different epiphyses fuse with the respective diaphyses in long bones. These variations have suggested need of separate standard of ossification for separate regions. This leads us to study ages of epiphyseal union around elbow joint, a rarely studied joint. Study was performed in total 320 healthy subjects having ages from 13 to 23 years and length of residence in Vidarbha more than 10 years. Chronological age upto the day of examination was determined and A-P view of right elbow joint was taken in each case. From this radiographs age of union of epiphyses around elbow joint is determined and compared with the other authors from other states of India and also with other countries and found to vary appreciably.

**Keywords:** Epiphysis, Elbow joint, Radius, Humerus.

### Introduction

Age is an important factor to be determined for a medico-legal expert. The registration of birth is still extremely incomplete in India and many times real age is concealed with various intentions. Because of this, we need some objective methods to find out exact age of a particular individual. The principle means, which enable a medical man to opine about the age of a person, are: - teeth, height, weight, puberty changes and ossification of bones etc. Among various methods of age determination, ages of appearance and union of epiphyses with diaphyses, as observed radiologically is considered to be a reliable guide and in many cases it is the only guide for anatomists and medico-legal experts for the estimation of age of the individual. These ages of appearance and union of epiphyses vary with racial, geographic, climatic and various other factors. Study of various text books in Anatomy and Radiology exhibits a glaring discrepancy as regards the ages at which the different epiphyses fuse with the respective diaphyses in long bones. Appreciable variations in the time of fusion of epiphysis with diaphyses have been recorded not only by the workers belonging to different countries (Pryor 1923<sup>17,18</sup>; Davies and Parsons 1927<sup>7</sup>; Paterson 1929<sup>16</sup>; Sidhom and Derry 1931<sup>20</sup>; Barret 1936<sup>2</sup>; Ledger and Wasson 1941<sup>13</sup>) but

even by the workers from the various provinces of the Indian subcontinent (Lal and Nat 1934<sup>11</sup>; Pillai 1936<sup>15</sup>; Galstaun 1937<sup>9</sup>; Basu and Basu 1938<sup>3,4</sup>; Lal and Townsend 1939<sup>12</sup>; Gupta *et al.* 1974<sup>8</sup>). Because of the existence of such racial, geographic and climatic variations, need for separate standards of ossification for separate regions have been suggested (Loder *et al.* 1993<sup>14</sup>; Koc *et al.* 2001<sup>10</sup>; Crowder *et al.* 2005<sup>6</sup>). So, the present work is undertaken as a pilot study to investigate the ages of epiphyseal union around elbow joint radiologically in boys and girls of Vidarbha region.

### Material and Method

Study was performed in total 320 healthy subjects having age from 13 to 23 years. The length of residence of each subject in Vidarbha region was ascertained and those having less than 10 years stay in the Vidarbha region were excluded from the present investigation. All the subjects belonged to middle socioeconomic status. Freedom from musculo-skeletal, nutritional and endocrine disorders and also from any debilitating ailments in childhood was taken into account. Height, weight and general physical development were recorded in all cases and the menstrual history of girls was also accounted for. Dietetic history was also taken for all subjects. Out of total 320 subjects examined, there were 144 boys and 176 girls. Accurate age, as far as possible, was determined in each case based on the statements of the subjects, supported by their school leaving certificates. The subjects were divided into ten groups as 13-14, 14-15, 15-16, 16-17, 17-18, 18-19, 19-20, 20-21, 21-22, 22-23 years according to their age. The distribution of boys and girls in each age group is shown in Table 1. All these subjects were examined clinically and radiologically. Anteroposterior views of right elbow were taken in each case.

### Criteria for union

The union was considered as complete when space between diaphyses (shaft) and epiphyses was fully obliterated and bony in architecture and density, indistinguishable from the epiphyses and

diaphyses in its neighbourhood. Periosteum between the epiphyses and diaphyses should be in continuity without any notching at the periphery of epiphyseal line. Cases of recent union, where a white transverse line was still seen in place of the epiphyseal cartilage, were also taken as

complete union and the so called epiphyseal scar was disregarded. The youngest age group showing complete union in 100% subjects was taken as criteria generalization.

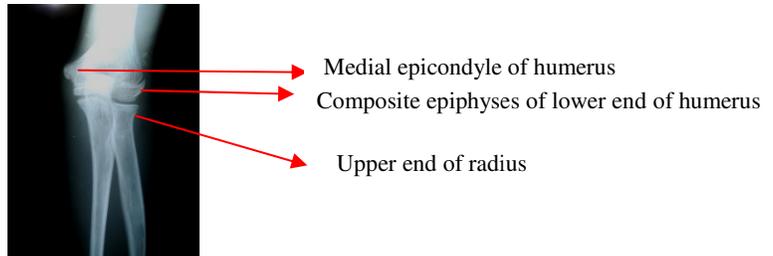


Figure 1: Antero-posterior view of elbow joint showing un-united epiphysis



Figure 2: Antero-posterior view of elbow joint showing completely united epiphysis

Table 1: Showing Distribution of no. of subjects and their percentage according to age and sex

Age (in years)	No of Cases		Total	%	χ <sup>2</sup> -value
	Boys	Girls			
13-14	0				8.5 Non Significant
14-15	0	12	12	3.75	
15-16	20	20	40	12.5	
16-17	16	20	36	11.25	
17-18	20	16	36	11.25	
18-19	20	24	44	13.75	
19-20	20	16	36	11.25	
20-21	16	20	36	11.25	
21-22	16	20	36	11.25	
22-23	16	16	32	10	
Total	144	176	320	100%	

Above table shows distribution of no. of subjects and their percentage according to age and sex and there is no significant difference in distribution of number of subjects in different age groups.

Table 2: Showing age of union of the composite epiphysis of lower end of humerus with shaft

Age group (Years)	Number of cases examined		Number of cases showing complete union		%	
	Boys	Girls	Boys	Girls	Boys	Girls
13-14	0	12	-	4	-	33.33
14-15	0	12	-	12	-	100
15-16	20	20	8	20	40	100
16-17	16	20	16	20	100	100
17-18	20	16	20	16	100	100
18-19	20	24	20	24	100	100
19-20	20	16	20	16	100	100
20-21	16	20	16	20	100	100
21-22	16	20	16	20	100	100
22-23	16	16	16	16	100	100

**Table 3:** Showing age of union of the medial epicondyle of humerus with shaft

Age group (Years)	Number of cases examined		Number of cases showing complete union		%	
	Boys	Girls	Boys	Girls	Boys	Girls
13-14	0	12	-	4	-	33.33
14-15	0	12	-	8	-	66.66
15-16	20	20	8	20	40	100
16-17	16	20	8	20	50	100
17-18	20	16	20	16	100	100
18-19	20	24	20	24	100	100
19-20	20	16	20	16	100	100
20-21	20	20	20	20	100	100
21-22	16	20	16	20	100	100
22-23	16	16	16	16	100	100

**Table 4:** showing age of union of the upper end of radius with shaft

Age group (Years)	Number of cases examined		Number of cases showing complete union		%	
	Boys	Girls	Boys	Girls	Boys	Girls
13-14	0	12	-	8	-	66.66
14-15	0	12	-	12	-	100
15-16	20	20	8	20	40	100
16-17	16	20	8	20	50	100
17-18	20	8	20	8	100	100
18-19	20	24	20	24	100	100
19-20	20	16	20	16	100	100
20-21	16	20	16	20	100	100
21-22	16	20	16	20	100	100
22-23	16	16	16	16	100	100

## Observation and Result

Youngest age group showing complete union of this epiphyses in 100% subjects is 16 to 17 years in case of males and 14 to 15 years in case of females (Table no. 2). In case of medial epicondyle of humerus, earliest age showing complete union in 100% cases is 17 to 18 years for males and 15 to 16 years for females (Table no 3). Earliest age group showing complete union of upper end of radius in 100% subjects is 17 to 18 years for males and 14 to 15 years for females (Table no 4).

## Discussion

A. Comparison of ages of epiphyseal union around elbow joint found in the present study with those reported by workers from other regions of India. (Table 5). In present study, age of union of epiphysis around elbow joint has been worked out and composite epiphysis of lower end of humerus is found to unite at 16 to 17 years for boys and 14 to 15 years for girls. The upper limit of this age corresponds with the age reported by Lal and Nat (1934)<sup>11</sup> for males and Lal and Townsend (1939)<sup>12</sup> for girls in U.P. The lower limit of the age corresponds with the age given by Galstaun (1937)<sup>9</sup> for both sex in Bengal ; whereas the age in present study is later than that reported by Basu and Basu(1938)<sup>3,4</sup> for Bengalee girls and MJS Pillai (1936)<sup>15</sup> for South Indians. The medial epicondyle of humerus is found to unite at 17 to 18 years in males and 15 to 16 years in females in present study. This age is earlier than that reported by Gupta *et al* (1974)<sup>8</sup> for Uttar Pradeshians but later than that given by Galstaun (1937)<sup>9</sup> for Bengalees. The age reported by MJS Pillai (1936)<sup>15</sup> corresponds with the lower limit of the age for boys in present study whereas the age given by Sahni and Jit (1995)<sup>19</sup> for Punjabi females corresponds with the upper limit of the age for girls in present study. Epiphysis of upper end of radius is found to unite at 17 to 18 years in males and at 14 to 15 years in females in present study. Age given by Lal and Nat (1934)<sup>11</sup> for males in U.P. and MJS Pillai (1936)<sup>15</sup> is similar to the lower limit of the age for boys in present study but the Pillai has not given the sex. Age given by Lal. and Townsend (1939)<sup>12</sup> for females in U.P. and by Sahni and Jit (1995)<sup>19</sup> for Punjabi females is later than the present study. Age reported by Galstaun(1937)<sup>9</sup> for Bengalees is similar to present study in case of females but earlier in case of boys. Similarly age reported by Basu and Basu (1936)<sup>3,4</sup> for Bengalee girls is earlier than present study. B. Comparison of ages of epiphyseal union around elbow joint found in the present study with those reported by workers from other countries (Table 6) Epiphyseal union is said be earlier in western than in eastern. But present study does not support this commonly accepted view. For composite epiphysis of lower end of

humerus, age reported by Sidhom and Derry (1931)<sup>20</sup> for Egyptian boys is later than present study. This age given by Ledger and Wasson (1941)<sup>13</sup> for Pakistanis is similar to present study in case of girls but earlier for boys. Age given by Frazer (1958)<sup>5</sup> for Europeans corresponds with upper limit of age for boys and lower limit of age for girls found in present study whereas the same age given by Gray (1995)<sup>1</sup> corresponds with lower limit of age in present study for either sex. In case of medial epicondyle of humerus, age reported by Ledger and Wasson (1941)<sup>13</sup> for Pakistanis is similar to present study in case of boys but earlier in case of girls whereas that given by Frazer (1958)<sup>5</sup> for Europeans corresponds to upper limit of age for boys and lower limit of age for girls found in present study. Age of union of upper end of radius found in present study is similar to the age reported by Sidhom and Derry (1931)<sup>20</sup> for Egyptian boys and Ledger and Wasson (1941)<sup>13</sup> for Pakistanis. It also corresponds with the age given by Frazer (1958)<sup>5</sup> for Europeans in case of girls but later in case of boys whereas the same age given by Gray (1995)<sup>1</sup> corresponds to the lower limit of the age found in present study for both sex. From this, it may be concluded that greater height of white races than eastern is not due to the time lag in the epiphyseal union but it may be due greater growth per year which may be contributed to genetic factors.

**Table 5:** Showing comparison of ages (years) of union of epiphyses around Elbow joint given by various workers in India with findings of present study

Authors	Composite Epiphyses of humerus			Medial Epicondyle			Upper end of Radius		
	Male	Female	Mixed	Male	Female	Mixed	Male	Female	Mixed
Lal and Nat (1934) (U.P.)	17 yrs	-	-	-	-	-	17 yrs	-	-
Lal and Townsend (1939) (U.P.)	-	15 yrs	-	-	-	-	-	16 yrs	-
Gupta <i>et al</i> (1974) (U.P.)	-	-	-	18-19 yrs	17-18 yrs	-	16-17 yrs (Inconclusive)	17-18 yrs (Inconclusive)	-
Galstaun (1937) (Bengal)	16 yrs	14 yrs	-	16 yrs	14 yrs	-	16-17 yrs	14-15 yrs	-
Basu and Basu (1938) (Bengal)	-	13-14 yrs	-	-	-	-	-	13-14 yrs	-
M.J.S. Pillai (1936) (South India)	-	-	14 yrs	-	-	17 yrs	-	-	17 yrs
Sahni and Jit (1995) (Punjab)	-	-	-	-	16 yrs	-	-	16 yrs	-
Present Study (2007) (Vidarbha)	16-17 yrs	14-15 yrs	-	17-18 yrs	15-16 yrs	-	17-18 yrs	15-16 yrs	-

**Table 6:** Showing comparison of ages (years) of union of epiphyses around Elbow joint given by various workers from other countries with findings of present study

Authors	Composite Epiphysis of lower end of humerus			Medial Epicondyle			Upper end of Radius		
	Male	Female	Mixed	Male	Female	Mixed	Male	Female	Mixed
Sidhom and Derry (1931) (Egyptian)	17-18 yrs	-	-	-	-	-	17 – 18 yrs	-	-
Ledger and Wasson (1941) (Pakistan)	14-15 yrs	14 – 15 yrs	-	17 – 18 yrs	14 – 15 yrs	-	17 – 18 yrs	14 – 15 yrs	-
Frazer (1958) (European)	17 yrs	14 yrs	-	18 yrs	15 yrs	-	16 – 17 yrs	14 – 15 yrs	-
Gray (1995) (European)	16 yrs	14 yrs	-	-	-	20 yrs	17 yrs	14 yrs	-
Present study (2007) (Vidarbha-India)	16-17 yrs	14 – 15 yrs	-	17 – 18 yrs	15 – 16 yrs	-	17 – 18 yrs	14 – 15 yrs	-

## Conclusions

Composite epiphysis of lower end of humerus showed union with metaphysis between 16 to 17 years in males and 14 to 15 years in females. Medial epicondyle of humerus united with the metaphysis at 17 to 18 years in males and 15 to 16 years in females. Upper end of radius fused with the metaphysis at 17 to 18 years in males and 14 to 15 years in females. Overall comparison with other provinces in India showed that the ages of epiphyseal union varies even in the different provinces of the same country. Again, the ages of epiphyseal union are found to vary greatly all over the world indicating the need for separate standards of ages of epiphyseal union for separate regions.

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