

# AGES OF EPIPHYSEAL UNION AROUND WRIST JOINT - A RADIOLOGICAL STUDY

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## ABSTRACT

Age is an important parameter for medico-legal cases. Many times doctors are called upon to give opinion about age of a person. For this objective methods of age determination are required. Age of epiphyseal union is an objective important method of age determination. But these ages varies with racial, geographic, climatic and various other factors. These variations have suggested need of separate standards of ossification for separate regions.

Present work is undertaken to work out ages of epiphyseal union around wrist joint for Vidarbha region. Study is carried out in total 80 healthy subjects (44 girls and 36 boys) aging from 13 to 23 years & having length of residence in Vidarbha not less than 10 years. The chronological age upto the day of examination is determined & A-P view of right wrist joint is taken in each case. These radiographs are studied to determine age of union of epiphyses of lower end of radius & lower end of ulna. These ages are compared with those reported from various states of India & also from other countries & found to vary appreciably. Sexual dimorphism for ages of epiphyseal union is also studied.

**Key words:** Epiphyses, ossification, radius, ulna

## INTRODUCTION

Determination of age of an individual is a subject matter of great medico-legal and academic interest. Very frequently doctors are required to opine about the age of a person which may be for medicolegal purpose, for juvenile court procedures, or for entry to the government services. Registration of birth is still extremely incomplete in India & many times real age is concealed with various intentions. Also many times mutilated skeletal remains of upper limb present as MLC work & it becomes difficult to comment on age of the bones. So it becomes necessary to use some objective method to find exact age of a person. Among various methods of age determination, ages of appearance & union of epiphyses with diphyses, as observed radiologically is considered to be a reliable guide.

Though these ages are fairly constant for a particular bone, there are great variations with racial, geographic, climatic & various other factors. Appreciable variations have been recorded not only by workers from different countries [ Pryor (1933)<sup>1</sup>,

Paterson (1929)<sup>2</sup>, Barret (1936)<sup>3</sup>, Ledger & Wasson (1941)<sup>4</sup>, Flecker (1942)<sup>5</sup> but even by the workers from various provinces of Indian subcontinent [Pillai (1936)<sup>6</sup>, Galstaun (1937)<sup>7</sup>, Loomba S.D. (1958)<sup>8</sup> Gupta et al (1974)<sup>9</sup> Saksena & Vyas(1969)<sup>10</sup> Due to this, need for separate standards of ossification for separate regions have been suggested [Loder et al (1993)<sup>11</sup>, Koc et al (2001)<sup>12</sup>, Crowder et al (2005)<sup>13</sup>. Such standard have been investigated in many states of India .But no such standards have been investigated for Vidarbha region. So the present work is undertaken to investigate the same in Vidarbha.

## MATERIAL & METHOD

The present study was carried out in the Department of Anatomy, Government Medical College and Hospital, Nagpur (Maharashtra). Study was performed in total 80 subjects (36 boys & 44 girls) having ages 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 socio-economic 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.

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Dietetic history was also taken for all subjects.

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 ages. The distribution of boys and girls in each age group is shown in Table 1.

All these subjects were examined clinically and radiologically. Antero-posterior views of right wrist joint was taken in each case.

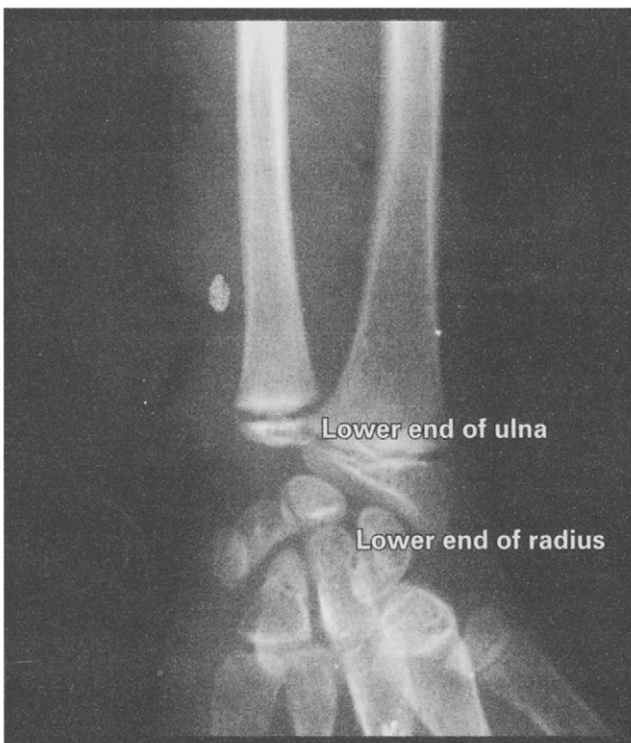
**Criteria of union:-**The union was considered as complete when space between diaphysis (shaft) and epiphysis was fully obliterated and bony in architecture and density, indistinguishable from the epiphysis and diaphysis in its neighbourhood. Periosteum between the epiphysis and diaphysis should be 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, was 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 for generalization.



A-P view of right wrist joint showing complete union of lower end of radius & ulna

**OBSERVATION & RESULTS**

Data is tabulated and statistically analysed as follows-  
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A-P view of right wrist joint showing un-united epiphyses of lower end of radius & ulna

Age(years)	No. of cases		Total	%	
	Boys	Girls			
13-14	0	3	3	3.75	8.5 Non Significant
14-15	0	3	3	3.75	
15-16	5	5	10	12.5	
16-17	4	5	9	11.25	
17-18	5	4	9	11.25	
18-19	5	6	11	13.75	
19-20	5	4	9	11.25	
20-21	4	5	9	11.25	
21-22	4	5	9	11.25	
22-23	4	4	8	10	
Total	36	44	80	100%	

**Table 1** Distribution of subjects according to age & sex

Age groups (Years)	Number of cases examined		Number of cases showing complete union		%	
	Boys	Girls	Boys	Girls	%	
					Boys	Girls
13-14	0	3	-	0	-	0
14-15	0	3	-	0	-	0
15-16	5	5	0	1	0	20
16-17	4	5	1	2	25	40
17-18	5	4	2	2	40	50
18-19	5	6	3	4	60	66.66
19-20	5	4	4	4	80	100
20-21	4	5	4	5	100	100
21-22	4	5	4	5	100	100
22-23	4	4	4	4	100	100

Table 2 - Age of Union of lower end of radius with shaft

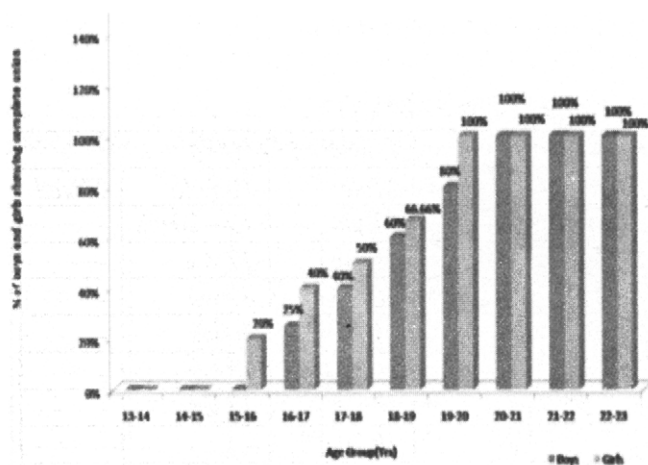


Fig.1 ages of union of lower end of radius

The complete union of lower end of radius is seen in 100% boys at 20-21 years & in 100% girls at 19-20 years. So, the age of union of lower end of radius is found to be 20-21 years for males & 19-20 years for female (Table 2, Fig.1).

Complete union of lower end of ulna is seen in 100% cases at 19-20 years in both sex. So, the age of union of lower end of ulna is found to be 19-20 years (Table 3, Fig.2).

Also, at any age epiphyseal union is found to be advanced in females than males. This present study supports commonly accepted view that epiphyseal union is earlier in females than males.

Age groups (Years)	Number of cases examined		Number of cases showing complete union		%	
	Boys	Girls	Boys	Girls	%	
					Boys	Girls
13-14	0	3	-	0	-	0
14-15	0	3	-	0	-	0
15-16	5	5	0	0	0	0
16-17	4	5	0	1	0	20
17-18	5	4	2	2	40	50
18-19	5	6	4	5	80	83.33
19-20	5	4	5	4	100	100
20-21	4	5	4	5	100	100
21-22	4	5	4	5	100	100
22-23	4	4	4	4	100	100

Table 3 - Age of union of lower end of ulna with shaft

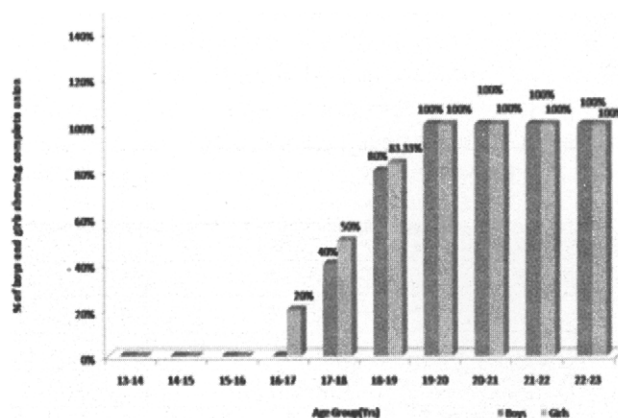


Fig.2 Ages of union of lower end of ulna

**DISCUSSION**

**A. Comparison of ages of epiphyseal union around wrist joint found in the present study with those reported by workers from other regions of India. (Table4)**

In present study, the age of union of epiphyses around wrist joint has been found out for Vidarb region & the age of fusion of lower end of radius is found to be 20-21 years in males and 19-20 years in females.

This age corresponds with the age reported by Loomba S.D. (1958)<sup>14</sup> for males, Gupta et.al. (1974)<sup>9</sup> for both sex in Uttar Pradesh. But the same age given by Loomba S.D. (1958)<sup>8</sup> for females, Banerjee &

Authors	Lower end of Radius		Lower end of ulna	
	Male	Female	Male	Female
Loomba S.D.(1958) (U.P.)	20 – 21 yrs	18 – 19 yrs	20 – 21 yrs	18 – 19 yrs
Gupta et al (1974) (U.P.)	20 – 21 yrs	19 – 20 yrs	20 – 21 yrs	20 – 21 yrs
Banerjee and Agrawal (1998) (U.P.)	19 – 20 yrs	18 – 19 yrs	19 – 20 yrs	18 – 19 yrs
Galstain (1937) (Bengal)	18 yrs	16 ½ yrs	18 ½ yrs	17 yrs
M.J.S. Pillai (1936) (South India)	18yrs	18yrs	18yrs	18yrs
Saksena and Vyas (1969) (M.P.)	19 – 20 yrs	17 – 18 yrs	19 – 20 yrs	17 – 18 yrs
Ranjets Das and Grewal (1965) (punjab)	Beyond 18 yrs	-	Beyond 18 yrs	-
Sahni and Jit (1995) (Punjab)	-	Above 16 yrs	-	Above 16 yrs
Present Study (2007) (Vidarbha)	20-21 yrs	19 – 20 yrs	19 – 20 yrs	19 - 20 yrs

Table 4  
Comparison of ages (years) of union of epiphyses around wrist joint given by various workers in India with findings of present study

Authors	Lower end of Radius			Lower end of ulna		
	Male	Female	Mixed	Male	Female	Mixed
Cunningham (1953) (European)	21 yrs	19 – 20 yrs	-	21 yrs	19 – 20 yrs	-
Frazer (1958) (European)	19 yrs	17 yrs	-	19 yrs	17 yrs	-
Gray (1995) (European)	19 yrs	17 yrs	-	18 yrs	17 yrs	-
Paterson (1929) (English)	21 yrs	20 yrs	-	21 yrs	20 yrs	-
Pryor (1923, 1933) (American)	19 yrs	20 yrs	-	19 yrs	18 yrs	-
Greulich and Pyle (1959) (American)	Beyond 18 yrs	17 yrs	-	18 yrs	17 yrs	-
Sidhom and Derry (1931) (Egyptian)	19 – 20 yrs	-	-	19 20 yrs	-	-
Barrett (1936) (Burmese)	-	17 yrs	-	-	17 yrs	-
Flecker (1942) ( Australian)	19 yrs	18 yrs	-	19 yrs	17 ½ yrs	-
Ledger and Wasson (1941) (Pakistani)	Above 20 yrs	18 – 19 yrs	-	18 – 19 yrs	16 – 17 yrs	-
Present study (2007) (Vidarbha - India)	20 – 21 yrs	19 – 20 yrs	-	19 - 20 yrs	19 - 20 yrs	-

Table 5  
Comparison of ages (years) of epiphyseal union around wrist Joint given by various workers from other countries with present study

Agrawal (1998) for Uttar<sup>14</sup>Pradesh, Galstaun (1937)<sup>7</sup> for Bengal, M.J.S.Pillai (1936) for South India<sup>6</sup>, Saksena & Vyas (1969)<sup>10</sup> for M.P., Ramji Das & Grewal (1965)<sup>15</sup> & Sahni & Jit (1995)<sup>16</sup> for Punjab are below the age found for Vidarbh.

The age of union of lower end of ulna found in present study is 19-20 years for both boys and girls. This corresponds with the age reported by Gupta et al (1974)<sup>9</sup> for Girls & Banerjee & Agrawal (1998)<sup>14</sup> for boys from Uttar Pradesh. However, age Reported by Gupta et.al (1974)<sup>9</sup> & Loomba S.D. (1958)<sup>8</sup> for boys is above the age found in present study; whereas, the age reported by Loomba S.D. (1958)<sup>8</sup> & Banerjee & Agrawal (1998)<sup>2</sup> in case of girls from Uttar Pradesh, Galstaun (1937)<sup>7</sup> for Bengalis, M.J.S.Pillai (1936)<sup>6</sup> for South Indians, Ramjee Das & Grewal (1965)<sup>15</sup> & Sahni & Jit (1995)<sup>16</sup> for Punjabis is below 19-20 years. The age given by Saksena & Vyas (1969)<sup>10</sup> for Madhya Pradeshians is earlier in case of girls but corresponds in case of boys.

#### **B.Comparison of ages of epiphyseal union around wrist joint found in the present study with those reported by workers from other countries (Table 5)**

Epiphyseal union is said to be earlier in western than in eastern. But Present study does not support this commonly accepted view.

The age of union of lower end of radius found in present study Corresponds with the age stated by Cunningham (1953)<sup>17</sup> for Europeans & Paterson (1929)<sup>16</sup> for English people. The age found in present study is above the age given by Pryor(1923,1933)<sup>18,1</sup> & Greulich & Pyle (1959)<sup>19</sup> for Americans, Sidhom & Derry(1931)<sup>19</sup> for Egyptian boys, Barrett (1936)<sup>3</sup> for Burmian females, Flecker (1942)<sup>5</sup> for Australians. Age given by Ledger & Wasson (1941)<sup>4</sup> for Pakistanis corresponds to present study for boys but earlier for girls.

For lower end of ulna, age in present study corresponds with Cunningham(1953)<sup>7</sup> for European girls, with Frazer(1958)<sup>21</sup> for European boys, with Pryor(1923, 1933)<sup>18,1</sup> for American boys, with Paterson(1929)<sup>2</sup> for English girls, with Sidhom & Derry(1931)<sup>20</sup> for Egyptian boys & with Flecker(1942)<sup>5</sup> for Australian boys. It is below the age stated by Cunningham (1953)<sup>17</sup> for European boys & Paterson (1929)<sup>2</sup> for English boys but above in all other cases.

#### **CONCLUSIONS**

Thus, ages of union of epiphyses around wrist

joint have been attempted in present study. For lower end of radius, it is found to be 20-21 years for boys & 19-20 years for girls & for lower end of ulna, it is found to be 19-20 years for both boys & girls.

On comparison with other authors, these ages are found to vary greatly not only all over the world but also in different states of India which may be due to the geographical variations. So, this suggests need of separate standard of ossification for separate regions.

From comparison with authors from western countries, 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.

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