

**ESTIMATION OF AGE BY X-RAY EXAMINATION OF DISTAL END OF HUMERUS**Anju Singh<sup>1</sup>, Dinesh Kumar Singh<sup>2</sup>, D. G. Paricharak<sup>3</sup>, Harshita Pant<sup>4</sup>**HOW TO CITE THIS ARTICLE:**

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**ABSTRACT:** Estimation of age of a person, whether living or dead, is vexing problem for medical jurist.<sup>1</sup> The duty of Forensic medicine knowledge expert is not only to examine dead bodies but also to give his opinion in living individual for solving various medico-legal problems like determination of age, identification, sexual assault, sterility, impotency, pregnancy, criminal abortion, disputed paternity, alcoholic intoxication etc. Skeletal age, dental age, morphological age, secondary sex character age are other method in use for asserting age of individual. In medico legal practice a combined view is taken and opinion is expressed after considering all methods. However radiological examination is a must and the court of law did not believe any conclusion without it.<sup>2</sup> **AIM AND OBJECTIVES:** An extensive work has been carried out on the theme in different states of India and abroad as well. However, very little work has been reported with reference to Agra (U.P.) population so the present study was conducted on Agra region population to study union of lower end of humerus for estimation of age. **MATERIAL AND METHODS:** This study was carried out in 100 males and 100 females between the age group of 10-20 years of normal healthy individuals whose exact date of birth was known were included in the study and the cases were collected from college and institutions by obtaining the permission from their head of the institution. In all cases right side is X-rayed (AP and Lateral view). **RESULTS:** It is clear from the observations that fusion of different ossification centers occurs 2-3 year earlier in female subjects as compared to male subject studied. It was found from the study that in females at the of 16 years all the epiphysis of lower end of humerus are fused. Medial epicondyle is the last epiphysis to fuse at lower end of humerus in both male and female. In male all epiphysis of lower end of humerus are fused except medial epicondyle at age of 16 years. The sequence of fusion at lower end of humerus was almost similar with other workers, however the range varied which can be attributed to many among other reasons i.e. geographical variation, nutritional factors etc. As no statistical tests were applied in present study that is also with relatively smaller sample size, we would feel to suggest larger study with statistical methods for incorporating the observations of present study as regional database.

**KEYWORDS:** Skeletal age, Radiological examination, union.

**INTRODUCTION:** The bony age is determined from the study of growing ends of long bones i.e. the appearance and fusion of epiphysis with the diaphysis. The bony age is considered nearest to accuracy in estimating the clinical age. The actual bony age can't be determined in living, therefore the law enforcing agencies has to rely upon radiological estimation of bony age that too with many limitations and conditions.

The complexity of overall ossification problem may be gleaned by the estimation that at the 11<sup>th</sup> prenatal week in humans there are some 806 centers of bone growth, at birth about 450, while the adult skeleton has only 206 bones.<sup>3</sup>

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It is an established fact that the sequence of appearance and ultimate ossification of epiphysis varies in both sexes in different part of the world to the extent that there are wide variation even in the population of the different states of a country.

In case of alleged rape when the sexual intercourse has taken place with the consent of the girl, to made it a cognizable criminal offence it has to be proved that the girl was <16 years of age. Because of the lack of relevant data the medical experts are not in a position to certify the age of the girl with the result that the accused get the benefit of doubt and is set free.<sup>4</sup> In the developed part of world, reference atlas for age estimation are also in routine use.<sup>5</sup>

Distal end of humerus showed complete fusion at the age of 15.5 in females and at age of 16 in males at Indian Knoll.<sup>6</sup> Sangma et al reported that in North east region girls fusion at elbow region was found completed at the age of 16 years. The regression equation reported was  $18.54+(0)X$  with 4.14 as standard error.<sup>7</sup> Memchoubi also conducted the age 16 in Manipuri girls with reference to completion of fusion at elbow region.<sup>8</sup> However, Basu & Basu have reported the age 17 for complete fusion at elbow region in young Bengali girls.<sup>9</sup>

Sahni et al examined both elbow and wrists of 149 females of Chandigarh (age group 11-19 Y) and reported that if the epiphysis of the medial epicondyle of the humerus not fused, the age of the girl would be <16 years.<sup>4</sup> Banerjee KK, Aggarwal BBL reported that in Delhi region in females lower end of humerus unites at age of 16-17 years whereas in males the lower end of humerus unites at 17-18 years.<sup>10</sup> Singh TH Bijoy examined 50 manipuri females to determine the age of majority and observed that at age 18 year there is 100% fusion at elbow joint.<sup>11</sup>

**MATERIAL AND METHODS:** The present study was carried out in the Forensic Medicine and Toxicology and Radiology Department of Sarojini Naidu Medical College, Agra. A total of 200 (100 males, 100 females) in the age group of 10-20 years were selected randomly from various schools of Agra Region. A written informed consent was taken.

### Criteria for selecting subjects:

1. They should be living in Agra for more than 5years.
2. They should be free from any physical disability or endocrine anomaly.
3. Only those cases were taken for the study whose date of birth is verified by their school or college authorities by birth certificate.
4. They should be natives of Agra migrants are excluded from the study.

The persons selected for study were groped as per their stated age, 10-11 years, 11-12 years, 12-13 years, 13-14 years, 14-15 years, 15-16 years, 16-17 years, 17-18 years, 18-19 years, and 19-20 years. Age as stated by them is further confirmed by birth certificate or entry in their school record each person is x-rayed for Right side elbow joint. Anteroposterior and Lateral view is taken and the skiagrams are studied in detail in reference to fusion of epiphysis at lower end of humerus.

For the study X ray films were divided into two groups for each epiphysis:

1. Those showing complete union.
2. Those showing non-union.

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Figure 5 : Micheal 13 Years 6 months male AP and Lateral view of right elbow joint showing all centres around lower end of humerus appeared but not fused.



Figure 7 : Pratibha 14 Years 6 months female AP and Lateral view of right elbow joint showing partial fusion of lateral epicondyle with capitulum and trochlea with capitulum and non fusion of medial epicondyle

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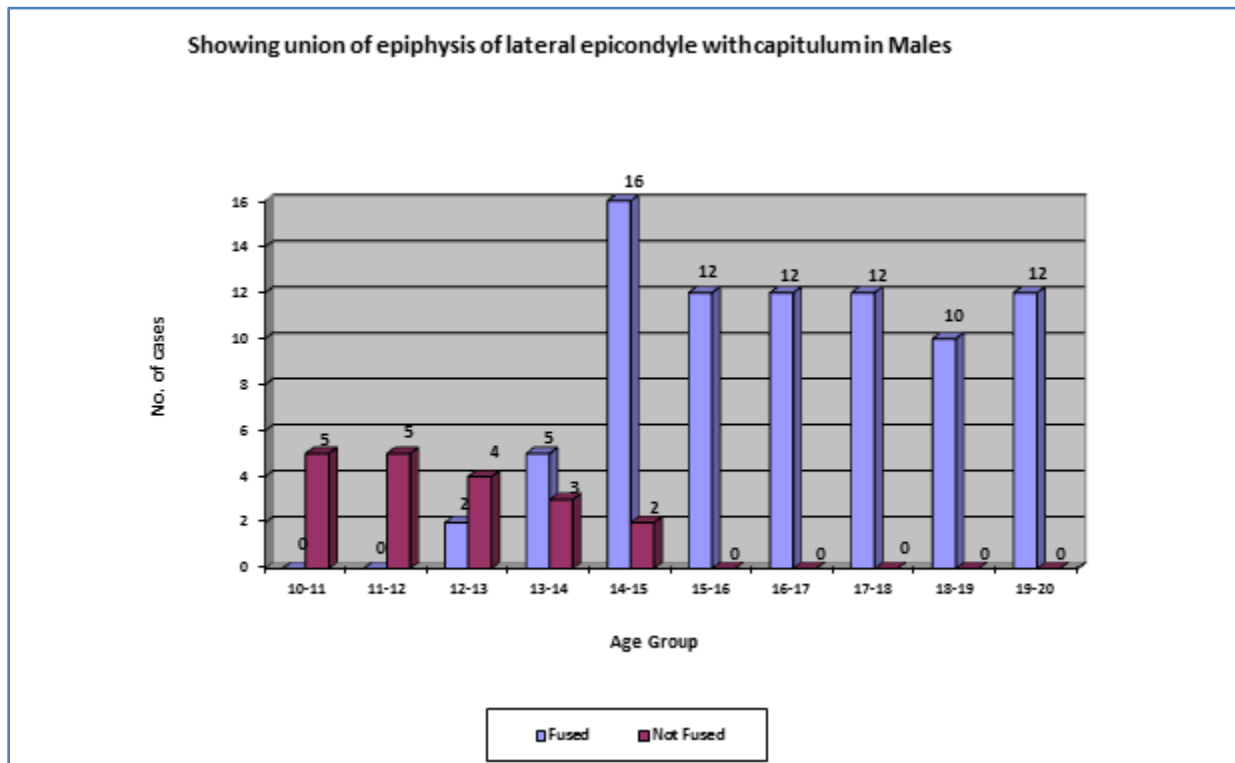
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### RESULTS AND DISCUSSION:

Age Group	No. of Cases examined	Fused	%	Not fused	%
10 – 11	5	0	0	5	100.0
11 – 12	5	0	0	5	100.0
12 – 13	6	2	33.33	4	66.67
13 – 14	8	5	62.50	3	37.50
14 – 15	18	16	88.88	2	11.12
15 – 16	12	12	100.0	0	0
16 – 17	12	12	100.0	0	0
17 – 18	12	12	100.0	0	0
18 – 19	10	10	100.0	0	0
19 – 20	12	12	100.0	0	0
Total	100	81		19	

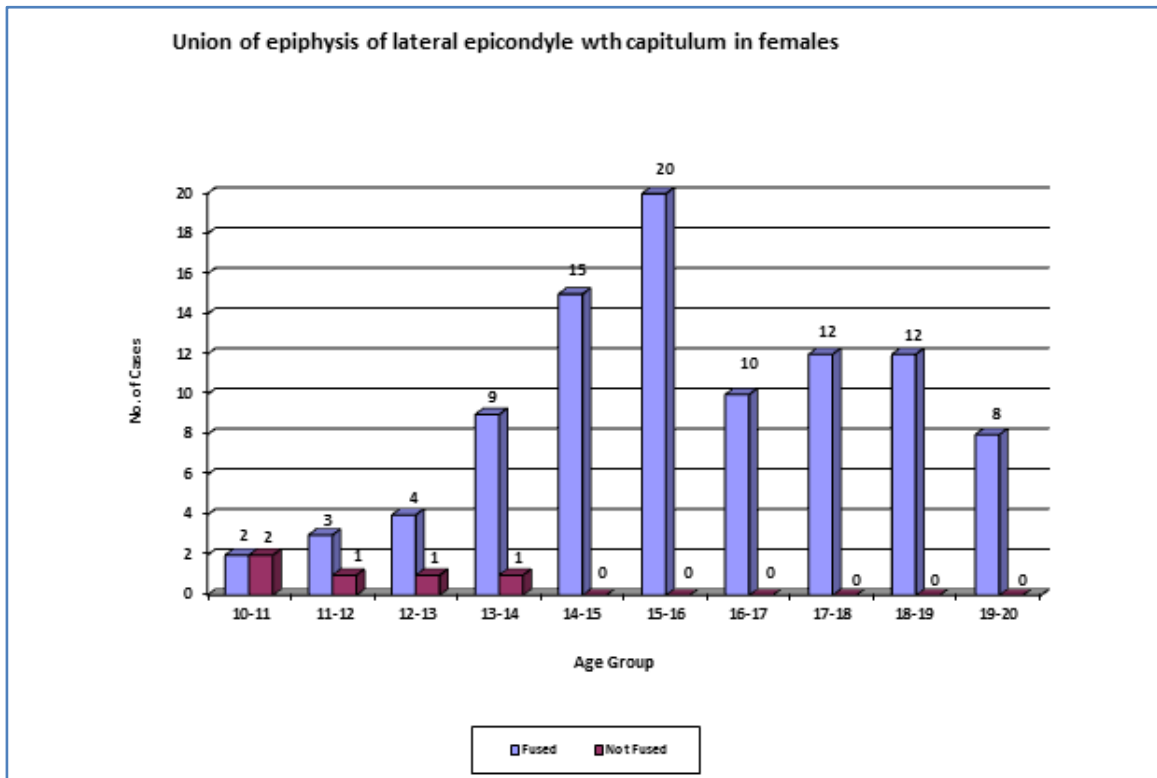
Table No. 1: Showing union of epiphysis of lateral epicondyle with capitulum in Males

The earliest fusion was seen in a boy of 12 years 8 months, the oldest who showed fusion was of 14 years 10 months. The average age or the union of epiphysis of capitulum with lateral epicondyle was 14 – 15 years (88.88%). The range was varying between 12 – 15 years. From the age group of 15 – 16 years complete fusion was observed in 100% of cases.





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Age Group	No. of Cases examined	Fused	%	Not fused	%
10 – 11	4	2	50.00	2	50.00
11 – 12	4	3	75.00	1	25.00
12 – 13	5	4	80.00	1	20.00
13 – 14	10	9	90.00	1	10.00
14 – 15	15	15	100.00	0	0.00
15 – 16	20	20	100.00	0	0.00
16 – 17	10	10	100.00	0	0.00
17 – 18	12	12	100.00	0	0.00
18 – 19	12	12	100.00	0	0.00
19 – 20	8	8	100.00	0	0.00
Total	100	95		5	

**Table No. 2: Showing union of epiphysis of lateral epicondyle with capitulum in Females**

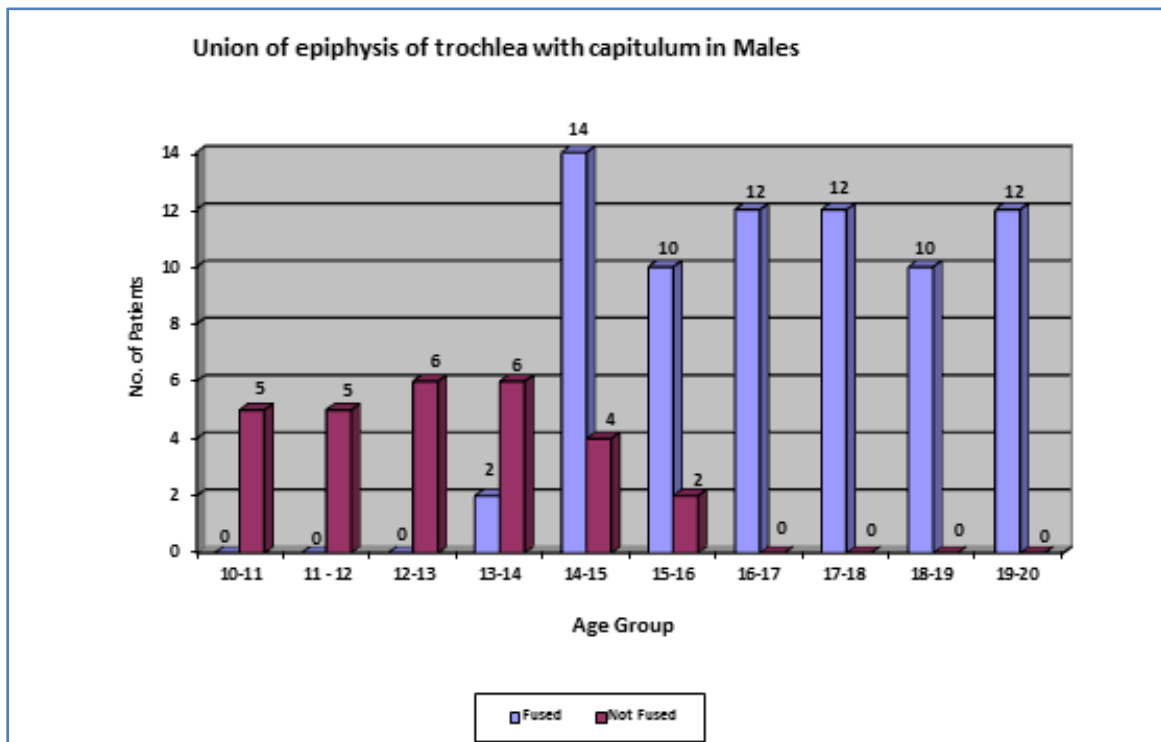
The earliest complete fusion of capitulum with the lateral epicondyle was seen in a girl aged 10 years 10 months. The oldest girl who showed fusion was aged 13 years 10 months. The range of fusion was between 10 to 14 years. In majority, the fusion had taken place at the age of 11-12 years (75%). The complete fusion was observed in 100% cases at the age of 14-15 years.

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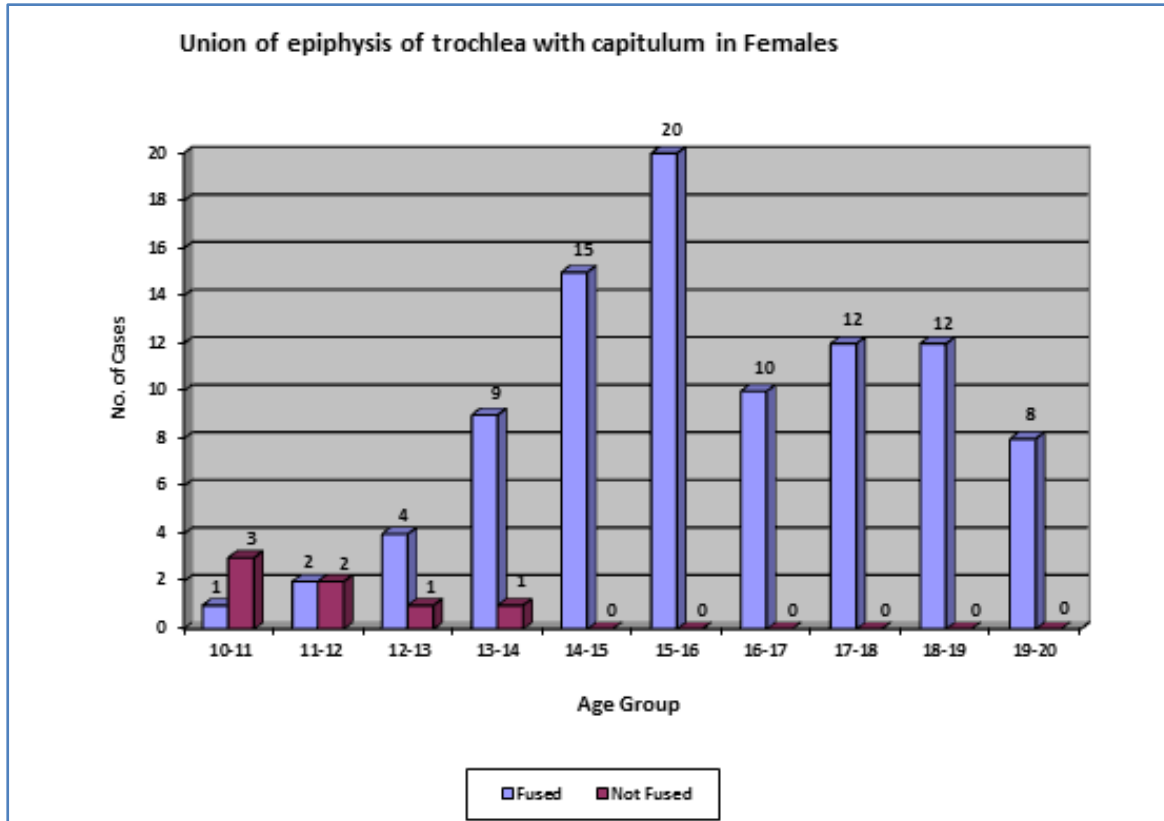
Age Group	No. of Cases examined	Fused	%	Not fused	%
10 – 11	5	0	0.00	5	100.00
11 – 12	5	0	0.00	5	100.00
12 – 13	6	0	0.00	6	100.00
13 – 14	8	2	25.00	6	75.00
14 – 15	18	14	77.78	4	22.22
15 – 16	12	10	83.33	2	16.67
16 – 17	12	12	100.00	0	0.00
17 – 18	12	12	100.00	0	0.00
18 – 19	10	10	100.00	0	0.00
19 – 20	12	12	100.00	0	0.00
Total	100	72		28	

**Table No. 3: Showing union of epiphysis of trochlea with capitulum in Males**

The earliest fusion of epiphysis of trochlea with capitulum was seen in a boy at the age of 13 years 7 months and the oldest boy who showed the fusion at the age of 15 years 8 months. Majority of cases showed fusion of trochlea with capitulum in the age group of 14 – 15 years (77.78%). The 100% fusion was noticed from the 16 – 17 age group. The range of epiphyseal union was between 13 – 16 years.



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Age Group	No. of Cases examined	Fused	%	Not fused	%
10 - 11	4	1	25.00	3	75.00
11 - 12	4	2	50.00	2	50.00
12 - 13	5	4	80.00	1	20.00
13 - 14	10	9	90.00	1	10.00
14 - 15	15	15	100.00	0	0.00
15 - 16	20	20	100.00	0	0.00
16 - 17	10	10	100.00	0	0.00
17 - 18	12	12	100.00	0	0.00
18 - 19	12	12	100.00	0	0.00
19 - 20	8	8	100.00	0	0.00
Total	100	93		7	

**Table No. 4: Showing union of epiphysis of trochlea with capitulum in Females**

The earliest fusion was noticed in a girl at the age of 10 years 11 months. The oldest girl showed fusion of trochlea with capitulum at the age of 13 years 8 months. In majority of females the union was observed between 12 - 13 years (80%). All the cases showed fusion ranging from 14 - 15 years (100%). The range of epiphyseal union was between 10 - 14 years.

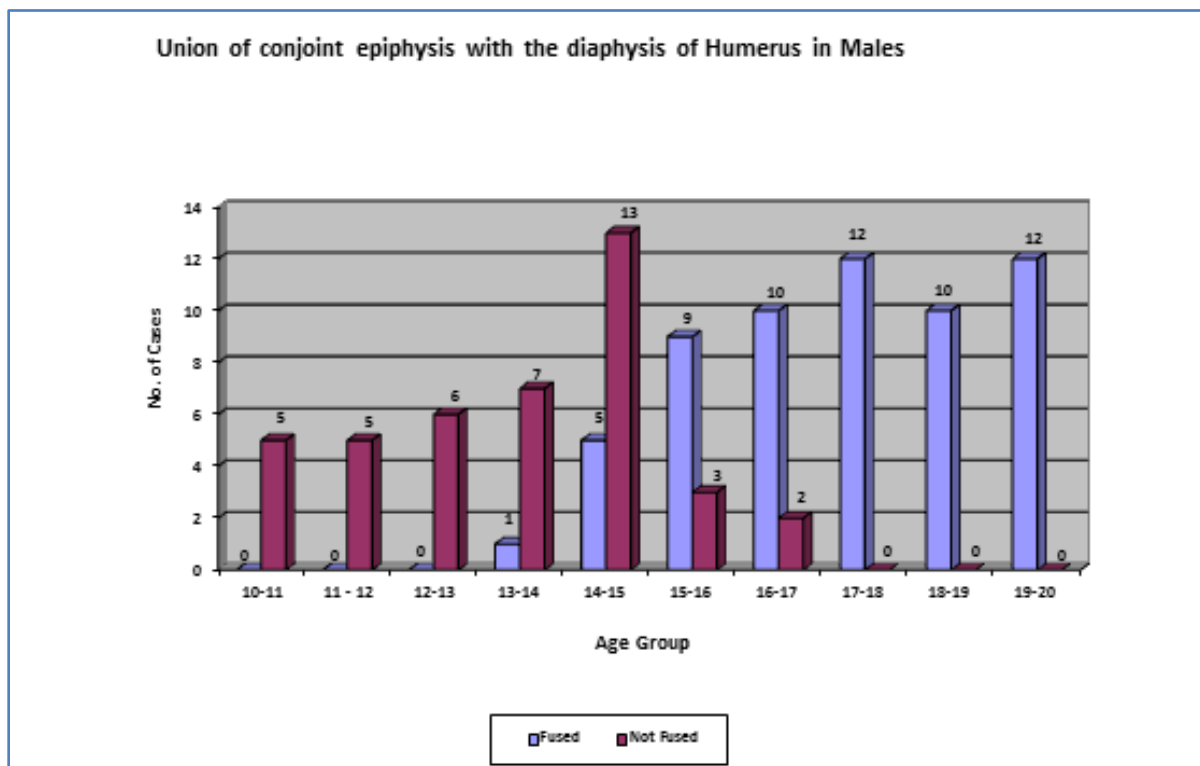
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Age Group	No. of Cases examined	Fused	%	Not fused	%
10 – 11	5	0	0.00	5	100.00
11 – 12	5	0	0.00	5	100.00
12 – 13	6	0	0.00	6	100.00
13 – 14	8	1	12.50	7	87.50
14 – 15	18	5	27.78	13	72.22
15 – 16	12	9	75.00	3	25.00
16 – 17	12	10	83.33	2	16.67
17 – 18	12	12	100.00	0	0.00
18 – 19	10	10	100.00	0	0.00
19 – 20	12	12	100.00	0	0.00
Total	100	59		41	

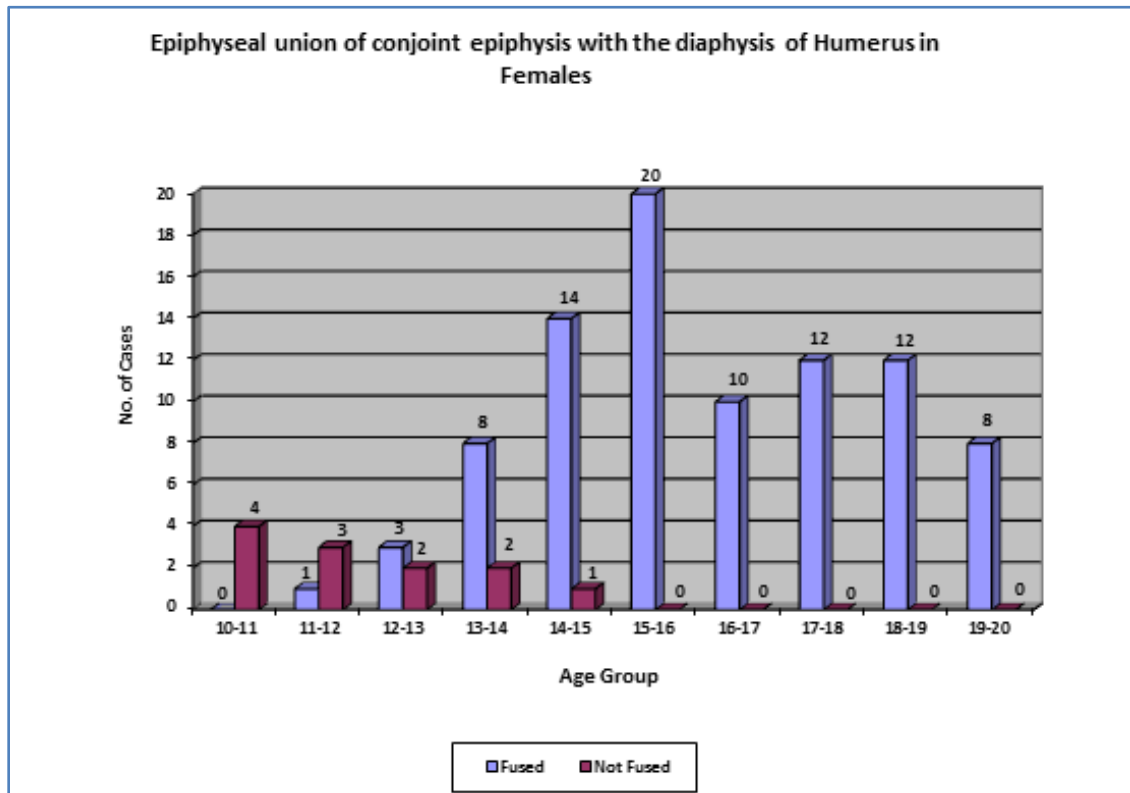
**Table No. 5: Showing union of conjoint epiphysis with the diaphysis of Humerus in Males**

The earliest epiphyseal union was seen in a boy at the age of 13 years 4 months and oldest subject showed fusion at the age of 16 years 8 months.

Majority of cases were having union in the age group of 15–16 years. The range was varying from 13 to 17 years and 100% union was seen from 17–18 years age group.



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Age Group	No. of Cases examined	Fused	%	Not fused	%
10 – 11	4	0	0.00	4	100.00
11 – 12	4	1	25.00	3	75.00
12 – 13	5	3	60.00	2	40.00
13 – 14	10	8	80.00	2	20.00
14 – 15	15	14	93.33	1	6.67
15 – 16	20	20	100.00	0	0.00
16 – 17	10	10	100.00	0	0.00
17 – 18	12	12	100.00	0	0.00
18 – 19	12	12	100.00	0	0.00
19 – 20	8	8	100.00	0	0.00
Total	100	88		12	

**Table No. 6: Showing epiphyseal union of conjoint epiphysis with the diaphysis of Humerus in Females**

The earliest complete fusion of conjoint epiphysis with diaphysis of Humerus was noticed in a girl at the age of 11 years 9 months and the oldest girl showed fusion at the age of 14 years 10 months 6 days. The range of epiphyseal union was observed between 11 – 15 years of age. In majority (80%) the epiphyseal union was seen in 13 – 14 years of age group and the complete union (100%) was seen from the 15 – 16 years age groups.

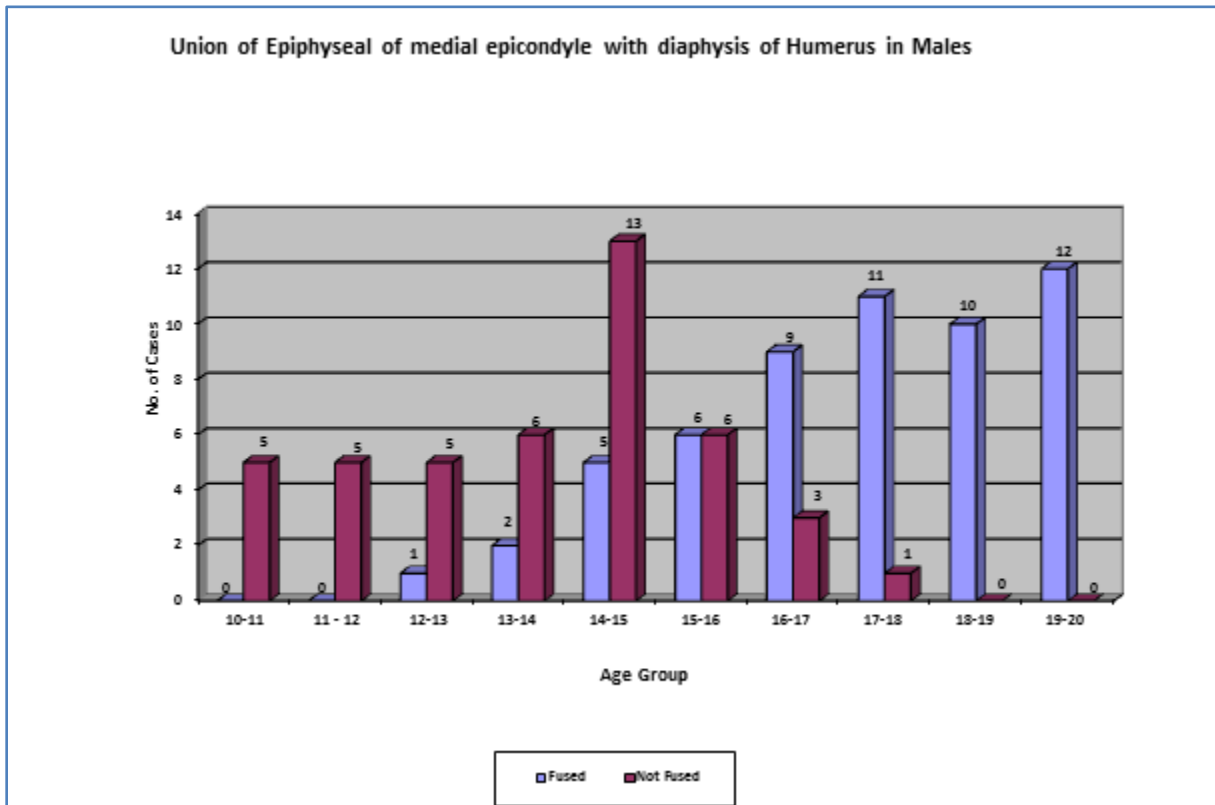
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Age Group	No. of Cases examined	Fused	%	Not fused	%
10 - 11	5	0	0	5	100.0
11 - 12	5	0	0	5	100.0
12 - 13	6	1	16.67	5	83.33
13 - 14	8	2	25.00	6	75.00
14 - 15	18	5	27.27	13	72.73
15 - 16	12	6	50.0	6	50.00
16 - 17	12	9	75.00	3	25.00
17 - 18	12	11	91.67	1	8.33
18 - 19	10	10	100.0	0	0
19 - 20	12	12	100.0	0	0
Total	100	56		44	

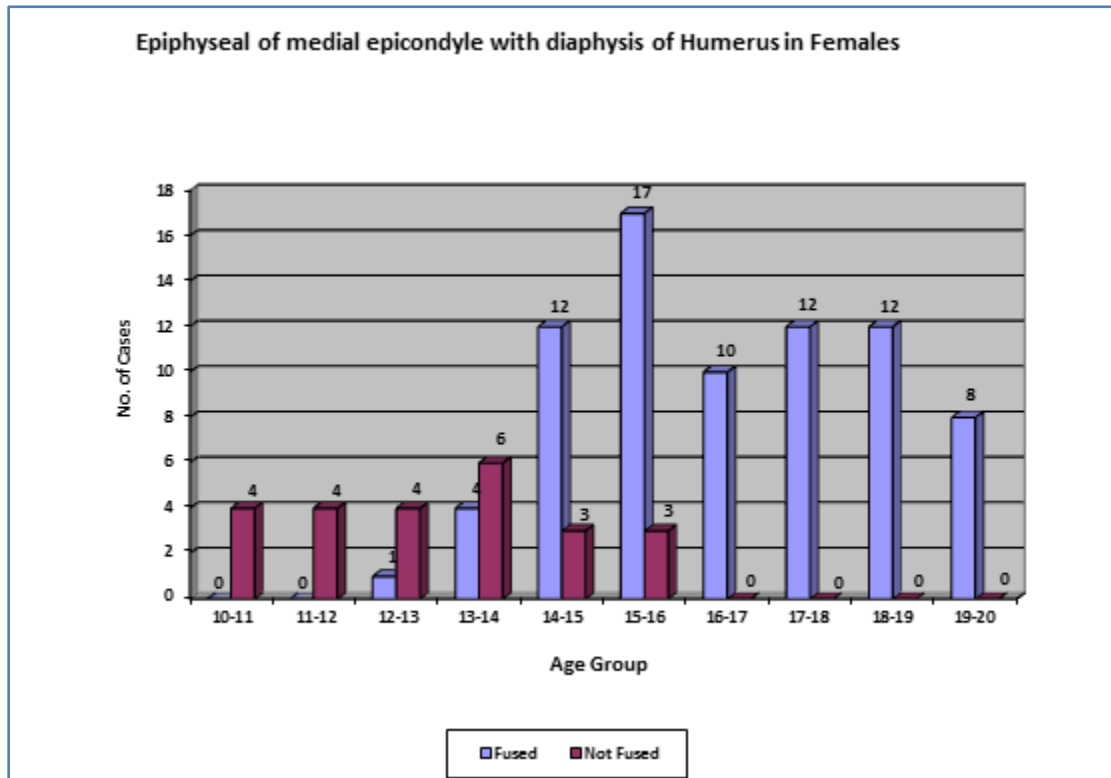
**Table No. 7: Showing epiphyseal of medial epicondyle with diaphysis of Humerus in Males**

The earliest fusion of medial epicondyle of Humerus with the shaft was seen in a boy at the age of 12 years 10 months 2 days and the oldest boy showed fusion at the age of 17 years 10 months 4 days.

The medial epicondyle completely fuses with shaft in majority of cases in 16 - 17 years (75%). The range of fusion was seen in 12 - 18 years. The 100% fusion of epiphysis was from the age group of 18 - 19 years.



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Age Group	No. of Cases examined	Fused	%	Not fused	%
10 - 11	4	0	0.00	4	100.00
11 - 12	4	0	0.00	4	100.00
12 - 13	5	1	20.00	4	80.00
13 - 14	10	4	40.00	6	60.00
14 - 15	15	12	80.00	3	20.00
15 - 16	20	17	85.00	3	15.00
16 - 17	10	10	100.00	0	0.00
17 - 18	12	12	100.00	0	0.00
18 - 19	12	12	100.00	0	0.00
19 - 20	8	8	100.00	0	0.00
Total	100	76		24	

**Table No. 8: Showing epiphyseal of medial epicondyle with diaphysis of Humerus in Females**

The earliest fusion of medial epicondyle of Humerus with the shaft was seen in a girl at the age of 12 years 6 months and 20 days while oldest girl showed fusion at the age of 15 years 10 months and 8 days.

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In majority of females the fusion was noticed at the age of 14 – 15 years (80%) and 100% fusion from the age of 16 – 17 years. The range of fusion was between the 12 – 16 years.

EPIPHYSIS	RANGE OF FUSION		AVERAGE AGE OF FUSION (Incidence of Fusion more than 75% cases)	
	Male	Female	Male	Female
<b>(Lower end of Humerus)</b>				
Lateral epicondyle with Capitulum	12 – 15	10 – 14	14 – 15	11 – 12
Trochlea with Capitulum	13 – 16	10 – 14	14 – 15	12 – 13
Conjoint epiphysis with diaphysis of Humerus	13 – 17	11 – 15	15 – 16	13 – 14
Medial epicondyle with diaphysis of Humerus	12 – 18	12 – 16	16 – 17	14– 15

**Table No. 9: Showing the age of fusion and range of fusion of lower end of Humerus as observed in the present work**

- The union of lateral epicondyle with capitulum takes place at the age of 11-12 years in girls and 14-15 years in boys.
- The fusion of trochlea with capitulum takes place at the age of 12-13 years in girls and 14-15 years in boys.
- The union of conjoint epiphysis with diaphysis of humerus takes place at the age of 13-14 years in girls and 15-16 years in boys.
- Medial epicondyle fuses with diaphysis at the age of 14-15 years in girls and 16-17 years in boys.(Table-9)

EPIPHYSIS	Males % Fusion	Females % Fusion
Lat epicondyle with capitulum	100	100
Trochlea with Capitulum	83.33	100
Conjoint epiphysis with diaphysis of Humerus	75	100
Medial epicondyle, with diaphysis of Humerus	50	85

**Table No.10: Epiphyseal Union at age of 16 years**

Lateral epicondyle with capitulum is fused in 100% cases in both males & females at the age of 16 years. Trochlea with capitulum & conjoint epiphysis with diaphysis of Humerus is fused in all cases of females & most cases of males (83.33%) & (75%) respectively at age of 16 years. (Table-10)

**DISCUSSION:** The epiphyseal union in females occur earlier than males by few months to 2 years. This is in consonance with various observations that in long bones females show fusion earlier than male.<sup>5, 6, 12</sup> The sequence of fusion at lower end of Humerus is in following order:

1. Lateral epicondyle with capitulum
2. Trochlea with Capitulum
3. Conjoint epiphysis with diaphysis of Humerus
4. Medial epicondyle with diaphysis of Humerus.



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Considering 75% as age of fusion all the epiphysis of lower end of humerus are fused in females at age of 16 years. These findings are similar with the finding of other workers.<sup>13</sup> In males all epiphysis of lower end of humerus are fused except medial epicondyle at age of 16 years. This is in consonance with various observations.<sup>14</sup>

Religion, diet, socio economic status had no effect on epiphyseal union. In assessing the age of candidates, radiological examination is of adequate help but with limitations. We recommend further study of larger geographical area and statistic tests for near scientific opinion in age assessment cases.

### REFERENCES:

1. Kangne RN, Sami SA and Deshpande VL. Age estimation of adolescent females by radiography. *JFMT* 1999; 16(1): 20-26.
2. Chokkar Vireder, Aggarwal SN and Bhardwaj DN. Estimation of age of 16 years in females by radiological and dental examination. *JFMT* 1992; ix (1, 2): 25-30.
3. Vij K. Textbook of forensic medicine and toxicology principles and practices, 4<sup>th</sup> edition, Elsevier: India, 2008: P: 54-55.
4. Sahni Daisy, Jit Indar and Sanjeev. Time of fusion of epiphysis at the elbow and wrist joints in females of Northwest India. *Forensic Science International* 1995; 74: 47-55.
5. Schmidt S, Koch B, Schulz R, Reisinger W and Schmeling A. Comparative analysis of the applicability of the skeletal age determination methods of Greulich-Pyle and Thiemann-Nitz for Forensic age estimation in living subjects. *Int J Leg Med.* 2007; 121 (4): 293-296.
6. Krogman W M and Iscan M Y. *The human skeleton in Forensic Medicine.* 2<sup>nd</sup> edition. Illinois: Charles C. Thomas; p.64
7. Dr Sangma William Bikley CH, Dr Marak Fremingston K, Dr Singh M Shyama and Dr Kharrubon Biona. Age determination in females of North Eastern region of India. *JIAFM.* 2007; 29 (4): 102-108.
8. Memchombi Ph. Age determination of Manipuri girls from the radiological study of epiphyseal union around elbow, knee, wrist joints and pelvis. *J Indian Acad Forensic Med.* 2006; 28 (2): 63-64
9. Basu S k and Basu S. A contribution to the study of diaphyseo-epiphyseal relations at the elbow of young Bengali girls. *Indian J Paed.* 1938;5:202-204
10. Banerjee KK, Aggarwal BBL. Roentgenologic study of epiphyseal union at the lower end of Humerus and femur bone in Delhi. *Journal of Indian Academy of Forensic Medicine.* 1997; 19 (1): 26-8
11. Th Singh Bijoy. Determination of age of majority of Manipuri females from the radiological examination of the joints, 2007; 7(2).
12. Reddy KSN. *The Essentials of Forensic Medicine and Toxicology*, 27<sup>th</sup> edition, K. Saguna Devi: Hyderabad, 2008: 64-74
13. Dr Sangma William Bikley CH, Dr Marak Fremingston K, Dr Singh M Shyama and Dr Kharrubon Biona. Age determination in females of North Eastern region of India. *JIAFM.* 2007; 29 (4): 102-108.

## ORIGINAL ARTICLE

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14. Das Gupta SM, Prasad Vinod, Singh Shamer. A roentgenologic study of epiphyseal union around elbow, wrist and knee joint and the pelvis in males and females of Uttar Pradesh. J Indian M A 1974; 62(1): 10-12.

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