

## A Radiological Study of Ossification at the Lower End of Humerus for Estimation of Age among Girls in Chattogram, Bangladesh

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### Abstract

**Background:** Estimation of the age of an individual from the appearance and the fusion of the ossification centers is considered as a reasonable well accepted method in the field of medical and legal professions. Age estimation is essential during employment, marriage, fixation of criminal responsibility, judicial punishment, exercise of adult franchise and many other purposes. Bony age can be determined by the study of ossification centers of long bones through the appearance and fusion of epiphysis with diaphysis. The challenges during estimation of bony age are varying from place to place depending on geographic terrain, climatic, dietetic, hereditary, disease and other factor. So this study aimed to look out the status of fusion of ossification centers at the lower end of humerus for estimation of age among girls in Chattogram.

**Material and methods:** This cross sectional observational study was performed in the period of July 2018 to June 2019 on normal healthy student of 12 to 20 year age from the Prabartak School and College, Chattogram and Chittagong Medical College, Chattogram. The students (50 girls) were taken as subject and they were divided in eight groups according to their age. X-ray of the right elbow joint of each and every subjects were taken in antero-posterior and lateral view. The x-ray films were studied radiologically and interpreted to estimate the age by union of ossification centers.

**Results:** The average age of epiphyseal union in Chattogram was found as follows: Fusion of lateral epicondyle with capitulum in girls at 12-13 years. Fusion of capitulum with trochlea in girls at 12-13 years. Fusion of distal conjoint epiphyses with shaft in girls at 12-13 years.

Fusion of medial epicondyle with shaft in girls at 13-14 years.

**Conclusion:** In general the union of the ossification centers occur within 12-14 years in girls.

**Key words:** Age; Diaphysis; Humerus; Ossification; Radiology.

### Introduction

The bony age can be determined by appearance and union of epiphysis with the diaphysis from the observation of growing ends of long bones.<sup>1,2</sup> The bones of human skeleton developed from separate ossification centers. From these centers ossification progresses till the bone is completely formed. These changes can be studied by the means of X-rays. So it is possible to determine the approximate age of an individual by radiological examination of bones till ossification is complete.<sup>3</sup> In developing countries, age estimation among the living is one of the most important tasks where birth records are not often well maintained.<sup>4</sup> In living body actual bony age cannot be determined. Therefore, law enforcing authority has to trust on radiological estimation of bony age with too many limitation and condition.<sup>2</sup>

Estimation of age is very significant in medico legal and academic interest. Often doctors are called upon to give an opinion regarding the age of an individual.<sup>5</sup> Age determination is most important in general law of power attaining maturity and in murder cases.<sup>1</sup> In such cases attempts have been made to dispose the body by mutilation, dismemberment, use of corrosives and action of fire and only skeletal component remains are available for examination.<sup>1</sup>

Estimation of age is important while taking consent or in cases relating to juvenile offenders, rape, kidnapping, employment in government establishments, competency as a witness, attainment of majority, nullity of marriage, child labour, fixation of criminal responsibility etc.<sup>6,7</sup> It is also important in admission of school and colleges, institutes or while competing in sports tournaments at regional or national levels.<sup>8,9</sup> A

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mistake in age estimation in all these cases may result in miscarriage of justice and verdicts.<sup>1</sup>

Eruption of teeth is most perfect method for age estimation. But estimation of age by X-ray of the bones is the only method after the eruption of 2<sup>nd</sup> molars at the age of 14 years.<sup>1</sup>

In the medical and legal profession estimation of age of an individual from the appearance and union of the ossification centers is a well-accepted method.<sup>10</sup> Age can be determined from radiography of skeleton from the time of its appearance about 20<sup>th</sup> weeks of gestation until early adulthood.<sup>11,12</sup> Epiphysis of the bones unites at a particular age and this age helpful in age estimation.<sup>6</sup>

The time of appearance of centers of ossification and the process of union of the epiphysis with the diaphysis has a sequence and time period. Considerable variation occur in this aspect, depending upon race, gender, geographical distribution, nutritional status, dietary habits, physical activity, hormonal and metabolic disorders, climate, heredity, socio economic condition of population.<sup>10, 12, 13</sup>

Ages of epiphyseal union have been found to differ in various regions of the same country and this has arisen a need to establish separate standards for separate regions even in the same country. In different states of India such standard have been investigated e.g Punjab, Uttar Pradesh, South India, Madhya Pradesh, Gujrat, Kolkata etc. In Chattogram there is no such standard present. Thus the current work is undertaken to estimate the age of union of ossification centers at the lower end of humerus by radiologically among the girls of Chattogram.

#### Material and methods

This cross sectional observational study was performed at the Department of Anatomy, Chittagong Medical College during the period of July 2018 to June 2019. The subject were taken as total 50 normal healthy students (Girls) of age group of 12 to 20 year from the Prabartak School and College, Chattogram and Chittagong Medical College, Chattogram. The age of the subject was verified by checking the date of birth from school and college admission records or city corporation birth record. After taking informed written consent from the all the subjects or from their guardian then socio demographic information on

the basis of objectives were collected. There having deformities of elbow joint, subject with signs of malnutrition or delayed milestones, subject with history or evidence of previous fracture near elbow joint, congenital anomalies and metabolic disease, left hand person or disagree to participate excluded from the study. The students (Girls) were divided in eight groups according to the age i.e. 12 to 13 years, 13 to 14 years, 14 to 15 years, 15 to 16 years, 16 to 17 years, 17 to 18 years, 18 to 19 years and 19 to 20 year. Then X-ray of the right elbow joint of all subjects were taken in antero-posterior and lateral view. The X-ray films were studied radiologically and interpreted to estimate the age by union of ossification centers.

This study ethically approved by ethical clearance committee of Chittagong Medical College, Chattogram.

#### Results

The earliest fusion of lateral epicondyle with the capitulum was seen in 12 years 1 month, the oldest fusion was in 12 years 10 month. The average age of fusion of lateral epicondyle with capitulum was in 12-13 years (100%). The range was varying between 12-13 years. From the age group of 12-13 years complete fusion was seen in 100% of cases. (Table I).

**Table I** Fusion of lateral epicondyle with the capitulum

Age Group (Years)	No. of Subject	Fused	%	Not Fused	%
12-13	6	6	100	0	0
13-14	6	6	100	0	0
14-15	6	6	100	0	0
15-16	7	7	100	0	0
16-17	6	6	100	0	0
17-18	6	6	100	0	0
18-19	6	6	100	0	0
19-20	7	7	100	0	0
Total	50	50		00	

The earliest fusion of capitulum with trochlea was seen in 12 years 2 months, the oldest fusion was in 12 years 8 month. The average age of fusion of capitulum with trochlea was in 12-13 years (100%). The range was varying between 12-13 years. From the age group of 12-13 years complete fusion was seen in 100% of cases (Table II).

**Table II** Fusion of capitulum with trochlea

Age Group (Years)	No. of Subject	Fused	%	Not Fused	%
12-13	6	6	100	0	0
13-14	6	6	100	0	0
14-15	6	6	100	0	0
15-16	7	7	100	0	0
16-17	6	6	100	0	0
17-18	6	6	100	0	0
18-19	6	6	100	0	0
19-20	7	7	100	0	0
Total	50	50		00	

The earliest fusion of distal conjoint epiphyses with shaft was seen in 12 years 4 month, the oldest fusion was in 12 years 11 month. The average age of fusion of distal conjoint epiphyses with shaft was in 12-13 years (100%). The range was varying between 12-13 years. From the age group of 12-13 years complete fusion was seen in 100% of cases (Table III).

**Table III** Fusion of distal conjoint epiphyses with shaft

Age Group (Years)	No. of Subject	Fused	%	Not Fused	%
12-13	6	6	100	0	0
13-14	6	6	100	0	0
14-15	6	6	100	0	0
15-16	7	7	100	0	0
16-17	6	6	100	0	0
17-18	6	6	100	0	0
18-19	6	6	100	0	0
19-20	7	7	100	0	0
Total	50	50		00	

The earliest fusion of medial epicondyle with the shaft was seen in 13 years 5 month, the oldest fusion was in 13 years 11 month. The average age of the fusion of medial epicondyle with shaft was in 13-14 years (100.0%). The range was varying between 13-14 years. From the age group of 13-14 years complete fusion was seen in 100% of cases (Table IV).

**Table IV** Fusion of medial epicondyle with the shaft

Age Group (Years)	No. of Subject	Fused	%	Not Fused	%
12-13	6	2	33.33	4	66.64
13-14	6	6	100	0	0
14-15	6	6	100	0	0
15-16	7	7	100	0	0
16-17	6	6	100	0	0
17-18	6	6	100	0	0
18-19	6	6	100	0	0
19-20	7	7	100	0	0
Total	50	46		4	

**Table V** Showing the average age of fusion and range of fusion at lower end of humerus as observed in the present study

Fusion of epiphysis (Lower end of humerus)	Range of fusion (Lower age limit in which minimum 50% showing complete union and upper age limit 100% union occur)	Average age of fusion (Youngest age group in which more than 75% union occur)
Lateral epicondyle with capitulum	12-13 years	12-13 years
Capitulum with trochlea	12-13 years	12-13 years
Distal conjoint epiphyses with shaft	12-13 years	12-13 years
Medial epicondyle with shaft	13-14 years	13-14 years

## Discussion

In the current study the average age of epiphyseal union of lower end of humerus in the girls of Chattogram was studied.

### *Fusion of Lateral Epicondyle with Capitulum*

In the current study the epiphyseal union was seen in the age of 12-13 years in girls which is one year prior to findings of previous studies done by Sharmain Uttar Prades, Kothati in Rajasthan and Shing in Agra India.<sup>14, 15, 2</sup> Reddy in Andhra Pradesh and Bhise in Mumbai India found the average age of fusion is 13-14 years in females which is one year delayed then our present study.<sup>16,3</sup> Jnanesh and Thomas presented a work in Karnataka India showing the age of fusion of lateral epicondyle in females at 12-13 years which is same as our present study.<sup>17</sup>

### *Fusion of Capitulum with Trochlea*

In the current study the epiphyseal union was seen at 12-13 years in girls which is same as the observation of Shing in Age and Jnanesh and Thomas in Karnataka India.<sup>2,17</sup> Sharma in Uttar Prades and Kothati in Rajasthan found the age of fusion is 11-12 years which is one year prior to our study result.<sup>14,15</sup> Bhise studied in Mumbai India found that age of fusion in females at 13-14 years which is one year delayed then current study.<sup>3</sup>

### *Fusion of Distal Conjoint Epiphyses with Shaft*

In the current study the age of fusion was found at 12-13 years in girls. Sharma in Uttar Pradesh and Jnanesh and Thomas in Karnataka India found that the age of union of epiphysis in females at 12-13 years which is same as our study result.<sup>14,17</sup> Kothari in Rajasthan studied the age of fusion at 11-12 years in females which is one year earlier

than in our present study.<sup>15</sup> Aggarwal found that epiphyseal union at 12-15 years in females which is also one year prior to our current study.<sup>18</sup> Dere conducted a study in Maharashtra India he was observed fusion of epiphysis at 11-13 years in female which is one year prior than current study.<sup>12</sup> Reddy in Andhra Pradesh and Shing in Agra region of India they found that the age of epiphyseal union in female at 13-14 years which is one year delayed than our study.<sup>16, 2</sup> Nandanwar studied in Baster region India he found that epiphyseal union in female at 14-15 years which is two years delayed than current study.<sup>5</sup>

#### *Fusion of Medial Epicondyle with Shaft*

In the present study the age of union was found at 13-14 years in girls which is similar with the study of Reddy in Andhra Pradesh, Bhise in Mumbai and Aggarwal in India.<sup>16,3,18</sup> Sharma in Uttar Pradesh, Kothari in Rajasthan, Jnanesh and Thomas in Karnataka and Shing in Agra region of India they found the age of union at 14-15 years in females which is one year delayed than our present study.<sup>14,15,17,2</sup> Nandanwar studied in Baster region India he found that epiphyseal union in female at 15-16 years in female which is two year delayed than our current study.<sup>5</sup>

#### **Limitations**

Resource constraints (time, availability of X-ray, budget) limited the total sample size to 50 girls. The socioeconomic status and ancestry of the individuals in the sample was not taken. Another potential limitation of the study is the lack of assessment of bilateral asymmetry. There was lack of radiographs of both hands from same individual at the same time for an assessment of asymmetry to be performed.

#### **Conclusion**

The average age of fusion of lateral epicondyle with the capitulum was 12-13 years in girls. The average age of fusion of capitulum with the trochlea was 12-13 years in girls. The average age of fusion of distal conjoint epiphyses with the shaft was 12-13 years in girls. The average age of fusion of medial epicondyle with the shaft was 13-14 years in girls.

#### **Recommendations**

Studies on larger samples are required to confirm the finding of this study. Future studies on large Chattogram sample of known and diverse ancestry

and socioeconomic backgrounds, may overcome any unintentional bias due to sampling. Any future studies would also benefit from an assessment of bilateral asymmetry in the timing of skeletal development. For furthermore studies may be expedient to work collaboratively with radiologists and forensic expert which would be mutually beneficial and would have the potential to contribute to their respective fields.

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#### **Contribution of authors**

RA- Conception, design, acquisition of data, interpretation of data, drafting and final approval.

MA- Conception, design, critical vision and final approval.

AD- Data collection, interpretation of data, manuscript writing and final approval.

NN- Design, data collection, data analysis and final approval.

AC- Data acquisition, manuscript drafting and final approval.

SC- Data acquisition, interpretation of data and final approval.

#### **Disclosure**

All the authors declared no competing interest.

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