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**Original Research Article**

# A radiological study of ossification at the lower end of humerus for age estimation among boys in Central Karnataka, India

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## ABSTRACT

**Background:** The earlier studies which were conducted across the world on long bones to know the age reveal that there is no uniform sequence for the epiphyseal union of long bones in different countries or different places in the same country. To ascertain this in Central Karnataka, India present study was done.
**Methods:** A radiological study of lower end of Humerus was conducted on total 100 boys of age group 11–20 years from different schools and colleges of Chitradurga district of central Karnataka, India. The radiographs were studied in detail and the findings were recorded.
**Results:** Fusion of epiphyseal centre of lateral epicondyle with that of Capitulum was seen between 12–15 years. Fusion of epiphyseal centre of Capitulum with that of Trochlea was seen between 12–15 years. Fusion of conjoint epiphysis with the shaft was seen between 12–16 years. Fusion of epiphyseal centre of medial epicondyle with shaft was seen between 14-17 years.
**Conclusions:** In general, fusion of epiphysis occurs around 12-17 years.

**Keywords:** Diaphysis, Epicondyle, Epiphysis, Humerus, Ossification

## INTRODUCTION

Bone is essentially a highly vascular, living, constantly changing and mineralized special connective tissue, which is remarkable for its characteristic growth mechanism.[1] The bony age can be determined from the study of growing ends of long bones.

Determination of the age is important in general law of power attaining maturity and in murder cases, where attempts have been made to dispose the body by mutilation, dismemberment, use of corrosives, action of fires, or in cases where murder was committed long ago and where only skeletal remains are available for examination. In living it is helpful in solving various medico legal problems. A mistake committed in this regard may be of serious consequences and may result in miscarriage of justice and verdicts.[2] Most preferred method of estimation of age is by using Eruption of teeth, but after the eruption of 2nd molars at the age of 14 years, X-ray of bones is the only method for estimation of age.

Extensive work on the determination of age of epiphyseal union has been carried out in different states of India as well as abroad and from the findings of various workers, it is evident that there is not only difference in the age of epiphyseal union in India and abroad, but also in different states of India.[3] The reason put forward for this variation could be factors like climate, diet, hereditary, racial, environmental and geographical.[4] According to several

workers epiphyseal union occurs 2-3 years earlier in Indians compared to western countries.[5-7] Hence to reinvestigate the problem radiological examination of the lower end of humerus was undertaken. This is the method through which study could be easily carried out without any inconvenience to the subjects participating in the study.

## METHODS

100 boys of Chitradurga district, Karnataka, India belonging to different communities studying in I) S.J.M. English Medium School, II) Bapuji Public School, III) S.J.M. College of Pharmacy and IV) S.J.M. Institute of Technology- Chitradurga, were studied by random sampling procedure.

### *Inclusion criteria*

- Subjects who are permanent resident of Chitradurga district (Karnataka).
- Subjects whose date of birth has been verified by the school and college.
- Written informed consent compulsory.

### *Exclusion criteria*

- Bad radiographic films.
- Deformities of elbow joint.
- Subjects less than 11 years and more than 21 years
- Subjects with signs of malnutrition
- Subjects having congenital anomalies, delayed milestones, infectious and metabolic disease.

A detailed personal and medical history was entered in the Performa. Height and weight were recorded using standard technique. Subjects were grouped into nine categories with minimum of 10 in each group. Antero-posterior and Lateral view of Right and Left elbow joint were taken in the Department of Radio-diagnosis, Basaveshwara Medical College and Hospital, Chitradurga. The present study consists of radiographs of the distal end of humerus showing the fusion of Capitulum, Trochlea, Lateral epicondyle and Medial epicondyle.

## RESULTS

The earliest fusion was seen at the age of 12 years 6 months 1 day (Figure 1) and the latest was seen at the age of 14 years 7 months 23 days (Figure 2) (Table 1).

The earliest fusion was seen at the age of 12 years 2 months 7 days (Figure 3) and the latest was seen at the age of 14 years 10 months 20 days (Figure 4) (Table 2).

The earliest fusion was seen at the age of 12 years 6 months 1 day (Figure 5) and the latest was seen at the age of 15 years 11 months (Figure 6) (Table 3).

**Figure 1: 12 years 6 months 1day male AP and Lat. view of Rt. and Lt. elbow joint showing earliest fusion of epiphysis of lateral epicondyle with capitulum.**

**Figure 2: 14 years 7 months 23 days male AP and Lat. view of Rt. and Lt. elbow joint showing latest fusion of epiphysis of lateral epicondyle with capitulum.**

**Table 1: Fusion of epiphysis of lateral epicondyle with capitulum.**

| Age Group (years) | No. of Subjects | Fused | % of fusion |
|---|---|---|---|
| 11 - 12 | 11 | 00 | 00 |
| 12 - 13 | 12 | 03 | 25.00 |
| 13 - 14 | 11 | 05 | 45.45 |
| 14 - 15 | 10 | 08 | 80.00 |
| 15 - 16 | 10 | 10 | 100.0 |
| 16 - 17 | 12 | 12 | 100.0 |
| 17 - 18 | 11 | 11 | 100.0 |
| 18 - 19 | 12 | 12 | 100.0 |
| 19 - 20 | 11 | 11 | 100.0 |
| Total | 100 | 72 | |

**Figure 3: 12 years 2 months 7 days male AP and Lat. view of Rt. and Lt. elbow joint showing earliest fusion of epiphysis of trochlea with capitulum.**

**Figure 4: 14 years 10 months 20 days male AP and Lat. view of Rt. and Lt. elbow joint showing latest fusion of epiphysis of trochlea with capitulum.**

**Table 2: Fusion of epiphysis of Trochlea with capitulum.**

| Age Group (years) | No. of Subjects | Fused | % of fusion |
|---|---|---|---|
| 11 - 12 | 11 | 00 | 00 |
| 12 - 13 | 12 | 05 | 41.66 |
| 13 - 14 | 11 | 08 | 72.72 |
| 14 - 15 | 10 | 09 | 90.00 |
| 15 - 16 | 10 | 10 | 100.0 |
| 16 - 17 | 12 | 12 | 100.0 |
| 17 - 18 | 11 | 11 | 100.0 |
| 18 - 19 | 12 | 12 | 100.0 |
| 19 - 20 | 11 | 11 | 100.0 |
| Total | 100 | 78 | |

**Figure 5: 12 years 6 months 1 day male AP and Lat. view of Rt. and Lt. elbow joint showing earliest fusion of conjoint epiphysis with diaphysis.**

**Figure 6: 15 years 11 months male AP and Lat. view of Rt. and Lt. elbow joint showing latest fusion of conjoint epiphysis with diaphysis.**

**Table 3: Fusion of conjoint epiphysis with the diaphysis of humerus.**

| Age group (years) | No. of subjects | Fused | % of fusion |
|---|---|---|---|
| 11 - 12 | 11 | 00 | 00 |
| 12 - 13 | 12 | 02 | 16.66 |
| 13 - 14 | 11 | 04 | 36.36 |
| 14 - 15 | 10 | 08 | 80.00 |
| 15 - 16 | 10 | 09 | 90.00 |
| 16 - 17 | 12 | 12 | 100.0 |
| 17 - 18 | 11 | 11 | 100.0 |
| 18 - 19 | 12 | 12 | 100.0 |
| 19 - 20 | 11 | 11 | 100.0 |
| Total | 100 | 68 | |

**Figure 7: 14 years 10 months 3 days male AP and Lat. view of Rt. and Lt. elbow joint showing earliest fusion of medial epicondyle with diaphysis.**

The earliest fusion was seen at the age of 14years 10 months 3 days (Figure 7) and the latest was seen at the age of 16 years 9 months 19 days (Figure 8) (Table 4).

**Figure 8: 16 years 9 months 19 days male AP and Lat. view of Rt. and Lt. elbow joint showing latest fusion of medial epicondyle with diaphysis.**

| Age group (years) | No. of subjects | Fused | % of fusion |
|---|---|---|---|
| 11 - 12 | 11 | 00 | 00 |
| 12 - 13 | 12 | 00 | 00 |
| 13 - 14 | 11 | 00 | 00 |
| 14 - 15 | 10 | 01 | 10.00 |
| 15 - 16 | 10 | 02 | 20.00 |
| 16 - 17 | 12 | 05 | 41.66 |
| 17 - 18 | 11 | 11 | 100.0 |
| 18 - 19 | 12 | 12 | 100.0 |
| 19 - 20 | 11 | 11 | 100.0 |
| Total | 100 | 44 | |

**Table 5: The range of fusion of lower end of humerus as observed in the present study.**

| Epiphysis (lower end of humerus) | Range of fusion (years) |
|---|---|
| Lateral epicondyle with capitulum | 12-15 |
| Trochlea with capitulum | 12-15 |
| Conjoint epiphysis with diaphysis of Humerus | 12-16 |
| Medial epicondyle with diaphysis of humerus | 14-17 |

## DISCUSSION

In the present study fusion of lateral epicondyle with the capitulum was seen to start after 12 years and gets 100% fused at 15 years which is one year later than the Rajasthani males by Kothari et al, two years earlier than England males by Patterson et al and this is very close to the study of Jnanesh done on Karnataka males, Davis and Parson on Englanders, Hepworth on Punjabi males and Anju Singh on Agra males.[2,8-12]

The fusion of trochlea to the capitulum was seen to start after 12 years and gets 100% completed at 15 years which is one year later than the Rajasthani males Kothari et al and England males by Patterson et al, this is similar to the study of Jnanesh et al done-on Karnataka males and Singh A on Agra males.[8-10,13] The fusion of Conjoint epiphysis with the diaphysis was seen to start after 12 years and gets 100% fused at the age of 16 years which is two years earlier than England males by Patterson and Rajasthani males by Kothari and very close to the study of Jnanesh on Karnataka males, Sidhom and Derry on Egypt males and Singh A on Agra males.[8-10,13] The fusion of Medial epicondyle with the diaphysis was seen to start after 14 years and 100% fused at 17 years which is two years earlier than study on Rajasthani males by Kothari and Patterson on England males, one year earlier according to Jnanesh on Karnataka males, Das Gupta et al on Uttar Pradesh males by Singh A on Agra males, the present study is very close to the study of Pillai on Madrasi males.[2,5,8-10,14] Religion, diet, socio-economic states had no effect on epiphyseal unions.

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