

Age Determination from Epiphyseal Union of Bones at Shoulder Joint in Boys of Central India

B. Tirpude*, V. Surwade**, P. Murkey*, P. Wankhade***, S. Meena****

Abstract

There is no statistical data to establish variation in epiphyseal fusion in Boys in central India population. This significant oversight can lead to exclusion of persons of interest in a forensic investigation. Epiphyseal fusion of proximal end of humerus in ninety males were analysed on radiological basis to assess the range of variation of epiphyseal fusion at each age. In the study the X ray films of the subjects were divided into three groups on the basis of degree of fusion. Firstly, those which were showing No Epiphyseal Fusion (N), secondly those showing Partial Union (PC), and thirdly those showing Complete Fusion (C). Observations made were compared with the previous studies.

Keywords: Epiphyseal Union; Shoulder Joint; Proximal End of Humerus.

Introduction

Epiphysis of the bones unites at the particular age which are remarkably constant for a particular epiphysis and this is helpful in age determination. In law the crime and punishment is entirely based on criminal responsibility and this in turn depends on the age of a person. Age is helpful in identification of an individual which in turn is helpful in both civil and criminal cases. It has been also stated that the study of epiphyseal union of bones is considered a reasonably accurate and accepted method for age determination by the lawcourts all over the world. As per Modi's textbook, owing to variation in climatic, dietetic, hereditary and other factors affecting the people of the different states of India, it cannot be reasonably expected to formulate a uniform standard for the determination of the age of the union of epiphyses for the whole of India. Union of epiphysis in cartilaginous bones takes place later in

the males by about 2 years than in females except in case of skull sutures where obliteration sets in little later and proceeds more slowly in females than in males and under tropical conditions ossification is observed earlier than in temperate areas. Reddy KSN(2009) stated that the bones of human skeleton develop from a number of ossification centers.

At eleventh to twelfth week of intrauterine life, there are 806 centers of ossification, at birth there are about 450. The adult human skeleton carries only 206 bones. Mehta Homi S (1963) observed that it has been approved by research in our country that the epiphysio-diaphysial union in Indian occurs about a year or two in advance of the age at which that occurs in Europeans. Jit and Kulkarni revealed that precocity of epiphyseal union has been attributed to racial and climatic factors. This difference could possibly be due to inadequate material or recording of incorrect ages of the subjects. By taking into consideration the radiological assessment in central India the study will be of help in further understanding the details of precise assessment of age in central Indian population.

Aims and Objectives

1. To estimate age from epiphyseal fusions at shoulder joint in Male subjects.
2. To assess age specific difference in epiphyseal fusion at shoulder joint in all subjects.

Authors Affiliation: *Professor & Head, *** Assistant Professor, **** Post Graduate Student, Department of Forensic Medicine, Mahatma Gandhi Institute of Medical Sciences, Sewagram, Wardha (MS) 442102. **Assistant Professor, R. D. Gardi Medical College, Surasa, Ujjain, M.P.

Reprints Requests: B.H. Tirpude, Professor & Head, Department of Forensic Medicine, Mahatma Gandhi Institute of Medical Sciences, Sewagram- 442102, Maharashtra.
E-mail: drtoshalwankhade@gmail.com

- To assess and evaluate the difference in the epiphyseal fusion at shoulder Joint in Central part of the India with other parts of India on the basis of previous studies.

Material and Methods

The study was carried out with the objective to assess the general skeletal maturity of subjects in Central India. Total ninety (90) males were taken in this study from age ranging from thirteen to twenty one years (13-21).

The individuals were selected from the following sources:

- Individuals admitted in Hospital for treatment purpose.
- Patients coming to the hospital for routine check-ups.
- Student coming to the hospital for Medical check-ups.

The individual chosen for the study were evaluated and confirmed for the following:

- They were born to parent native of Central India and lived here since birth.
- They have authentic documentation of their date of birth. (Birth certificate, School leaving certificate, Hospital records, School records)
- Individuals involved in study were predominately right handed.

Exclusion Criteria

- The subjects should not have any bony deformity or pathology, congenital malformation, nutritional deficiency, endocrinal disorders, history of chronic drug intake (e.g.) anti-epileptic drugs, steroids and chronic illness thus affecting the skeletal growth and development of the individual.
- Those who have no valid Date of Birth certificates.

Procedure of Radiography

After taking the written consent the thorough physical examination and radiological evaluation was done. X-Rays were taken with the help of X-Ray machine in the Department.

Minimum shots were taken to expose the joints

involved in study and minimum and appropriate voltage settings of X-Ray machine were applied so as to avoid unnecessary radiation exposure of the subjects to get the desired qualities of X-Rays. All the radiological procedure was undertaken according to the prescribed standards. Skeletal maturity was evaluated according to the Jits and Kulkarni's classification of four stages, Appearance, Non fusion, Partial fusion, and complete fusion ("NF", "PF", "CF" respectively).

X-Rays showing clear gap between the epiphyseal and diaphysial, showing saw tooth like Appearance end were designated as "Non-fusion" (NF) X-rays. The X-rays showing a line replacing the hiatus between the epiphyseal and diaphysial ends and not showing saw tooth like appearance were designated as "Partial Fusion" (PF) X-rays. X-Rays showing the same bony architecture in the diaphysis and epiphysis and showing scar of the previous stage were designated as "Complete Fusion" (CF). The master chart was prepared and tabulated as per code number given above. It was classified, analysed and compared with known standards. Data analysis was done EPI Info software. At the end conclusions were drawn which were compared with available results of various previous studies.

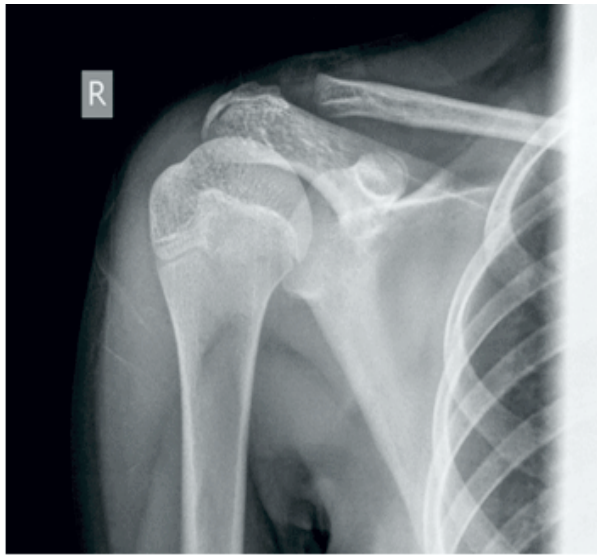
Result

Proximal end of Humerus in males shows partial fusion in 2 (2.22%) in 14-15 years of age group. 3 (3.33%) in 15-16 years age group. 8 (8.88%) cases and 3 (3.33%) cases in 16-17 years and 17-18 years of age group respectively.

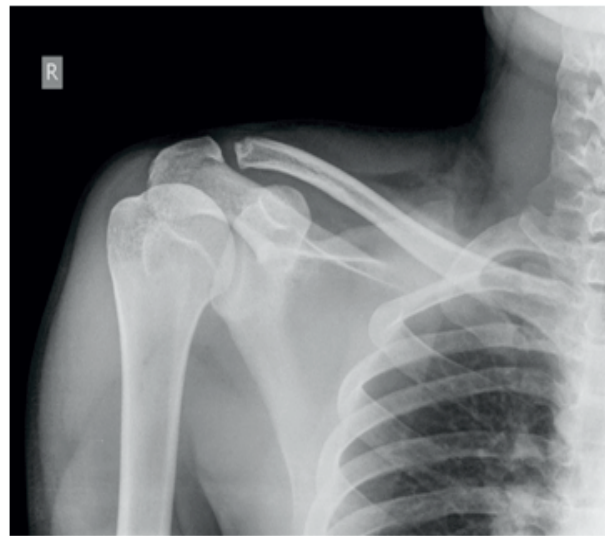
Proximal end of Humerus in males was



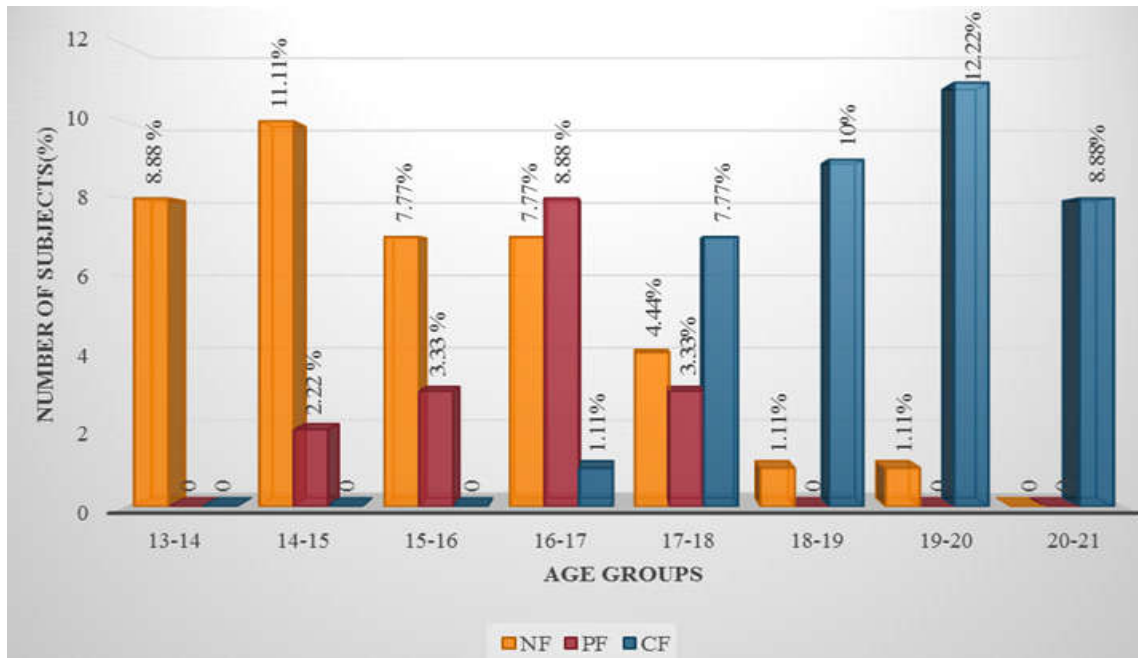
Photograph 1: AP View of shoulder shows Non-fusion of proximal end of Humerus



Photograph 2: AP View of shoulder shows partial fusion of Proximal end of Humerus



Photograph 3: AP View of shoulder shows complete fusion of Proximal end of Humerus



Graph 1: Trend of fusion at proximal end of humerus in male subjects

Table 1: Percentage of fusion in cases in males

| Age in years | NF | PF | CF | Total |
|-----------------|------------------|------------|------------|------------|
| 13-14 | 8(8.88%) | 0(0%) | 0(0%) | 8(8.88%) |
| 14-15 | 10(11.11%) | 2(2.22%) | 0(0%) | 12(13.33%) |
| 15-16 | 7(7.77%) | 3(3.33%) | 0(0%) | 10(11.11%) |
| 16-17 | 7(7.77%) | 8(8.88%) | 1(1.11%) | 16(17.77%) |
| 17-18 | 4(4.44%) | 3(3.33%) | 7(7.77%) | 14(15.55%) |
| 18-19 | 1(1.11%) | 0(0%) | 9(10%) | 10(11.11%) |
| 19-20 | 1(1.11%) | 0(0%) | 11(12.22%) | 12(13.33%) |
| 20-21 | 0(0%) | 0(0%) | 8(8.88%) | 8(8.88%) |
| Total | 38(42.22%) | 16(17.77%) | 36(40%) | 90(100%) |
| χ^2 -value | 78.1019 | | | |
| p-value | 0.000, S, p<0.05 | | | |

Table 2: Comparison of age of proximal end of humerus in various regions and races with present study

| S.N. | Researcher | Region | Age of fusion Male |
|------|--------------------------|----------------------|--------------------|
| 1) | Paterson (1926) | England | 21 |
| 2) | Davies and Parson (1927) | England | 19-21 |
| 3) | Flecker (1932) | Australia | 19 |
| 4) | Pillai (1936) | Madras | 19-20 |
| 5) | Galstaun (1937) | Bengal | 14-18 |
| 6) | Krogman (1960) | USA | 20-22 |
| 7) | Reddy KSN (1973) | Andhra Pradesh | 18-19 |
| 8) | Sahana S.N (1986) | Bengal | 20 |
| 9) | Knight B(1996) | UK | 16-23 |
| 10) | Saini et al (2005) | Rajasthan | 18-19 |
| 11) | Agrawal Anil (2006) | Delhi | 18 |
| 12) | Memon et al (2006-08) | Pakistan | 17-18 |
| 13) | Cardoso Hugo (2008) | Spain | 23 |
| 14) | Schaefer M.C.(2008) | Bosnia | 20-21 |
| 15) | Pimple et al (2013) | Mumbai | 18-19 |
| 16) | Present Study | Central India | 18-19 |

completely fused in 1 (1.11%) cases in 16-17 years, 7 (7.77%) cases shows complete fusion in 17-18 years and 9 (10%) cases seen in 18-19 years of age group. In 19 (21.1%) cases complete fusion was seen in age group of 19-21 years.

Discussion

It is observed that in the age group of 13-14 years of Males, non-fusion was seen in 8 (8.88%) cases. In the age group of 14-15 years, non-fusion was observed in 10 (11.11%) cases and in 2 (2.22%) cases it shows that, epiphysis being partially fused. In the age group of 15-16 years, 7 (7.77%) cases were non fused and 3 (3.33%) cases were partially fused.

Complete fusion is seen in Age group of 16-17 years, in 1 (1.11%) case. In the age group 17-18 years, it shows that out of total 14 cases, non fusion was observed in 4 (4.44%) cases, partial fusion was observed in 3 (3.33%) cases and in 7 (7.77%) cases, complete fusion was observed in male subjects. It is interesting to note that, the rate of complete fusion is increased in male from age group of 18-19 years and onwards with 9 (10%) cases out of 10 in 18-19 years of age, 11 (12.22%) cases out of 12 cases in 19-20 years and 8 (8.88%) cases out of 8 cases in the age group of 20-21 years. Average age of complete fusion of proximal end of Humerus in the male subjects was 18-19 years in present study.

Summary & Conclusion

1. This study was conducted exclusively on the young indigenous population of Central India

keeping in mind that very less literature about the age estimation from ossification of shoulder joint is available involving this particular region of India.

2. The ossification at the Shoulder joint in Males is completed in all instances (100%) at the age groups of 17-18 year respectively.
3. By comparing the available literature about ossification of long bones, fusion was delayed one to three years in this study with population of Central India than those parts of Eastern India in the population of Bengal.
4. By comparing the available literature the age of skeletal maturity in males in this region are nearly similar to those in population of Western Maharashtra and Rajasthan.
5. As this study is done in Central India region the application of standards of this study may be considered ideal for application in the region of Central India.
6. Population in Central India is mixed type comprising of various religions and castes, so this study is not applicable to specific caste or religion for estimation of age.
7. Due to changing life style pattern, dietary, climatic, behavioral factors; age of ossification is changing as mentioned in the available literature. So as to evaluate these changes, studies are recommended in every region of India at regular time period for academic and judicial interest.
8. Due to very narrow borderline range of differentiation between various stages of fusion, it is difficult to consider stage of fusion as age indicator.

9. For Radiological study, proper exposure of X-ray, proper positioning while X-ray shooting and proper development of digital X-rays (DX) is necessary.
10. Radiological interpretations are observer dependent so the set standards should be considered under expert guidance to arrive at conclusion in such radiological studies.
11. Along with clinical and dental examination, radiological study plays an important role to arrive at the opinion about the age in medicolegal cases.
12. The opinion about age should always be given in the range. From this study, range of 1-2 years of margin of error can be concluded.
13. For estimation of age relevant joints should be radiologically examined for different centres and opinion should be arrived considering the status of multiple centers.
14. With similar findings we have observed, there is enhancement of belief in the theory that the similarities in geographic-climatic condition, ethnicity, socioeconomic status, dietary habits have the common influence on the fusion of epiphysis with the age.

Limitations of Study

1. Population in Central India is mixed type comprising of various religions and castes so this study is not applicable to specific caste or religion.
2. Dietary, religious, economic, environmental factors are not studied in the present context.
3. As the number of subjects were less, for confirmation of various variations, more studies are required.

References

1. Aggarwal A. Ages of ossification-Personal Identification in Self-Assessment and Review of Forensic Medicine and Toxicology. 1st ed. Delhi: Jaypee Publishers and Distributers (P) Ltd. 2006; 51-59.
2. Alcazar ML, Alvear J, Muzzo S. Influence of Nutrition on the bone-development in the child. *Archivos Latinoamericanos De Nutrition*. 1984; 34 (2): 298-307.
3. Bajaj ID, Bharadwaj OP, Bharadwaj S. Appearance and fusion of important ossification centers - A

- study in Delhi population. *Indian J. Med Res*. 1967; 55: 1064-1067.
3. Bargotra RN, Bargotra M and Singh J. The time of fusion of medial epicondyle of Humerus in residents of Jammu And Kashmir State. Paper read at 38th annual conference, 1989 of Anat. Soc. of India. Abstract published in *Journal of Anatomical Society of India*. 1990; 39: 76.
4. Bokariya P. Effects of dietary habits on epiphyseal fusion. *Journal of Ind. Academy of Forensic Med*. 2008/2009; 34-37.
5. Camps Francis E. *Gradwohl's Legal Medicine* 3rd ed. Bristol: John wright and Sons Ltd. 1976; 140-141.
6. Cardoso Hugo FV. Age estimation of adolescent young adult male and female skeletons II, Epiphysial Union at the Upper Limb and scapular Girdle in a modern Portuguese Skeletal sample. *American J of Physical Anthropology*. 2008; 137: 97-105.
7. Chaurasia BD. *Human Anatomy. Regional and applied* 2nd edition. 1989. CBS Publishers and Distributors. p. 3-11.
8. Davies, DA, Parson FG. The age order of the appearance and union of the normal epiphyses as seen by X-rays. *J. Anat*. 1927; 62: 58-71.
9. Flecker H. Roentgenographic observations of the times of appearance of epiphysis. *J Anat*. 1932; 67: 188-164.
10. Flecker H. *Anatomical Society of India*. 1931 October, Vol.67.
11. Galstaun G. A study of ossification as observed in Indian subject. *Ind j Med Res*. 1937; 25(1): 267-324.
12. Garn SM, Rohman CG, Bluementhalt. Ossification sequence polymorphism and sexual dimorphism in skeletal development. *Am J Physical Anthropology*. 1996: 101-115.
13. Gopalan C. *Nutritional problems and programs in south East Asia*, New Delhi: WHO Regional office for south East Asia. 1987.
14. Graham CB. Assessment of bone maturation methods and pitfalls. *Radiolclin North America*. 1972; 10: 185-202.
15. Haines RW, Mohiuddin A, Okpa FI and Viega-Pires JA. The study of early epiphyseal union in the limb girdles and major long bones of man. *J Anat*. 1967; 101(4): 823-831.
16. Hepworth SM. Determination of age in Indians from study of the calcification of the long bones. *Ind Med Gaz*. 1929; 64: 128.
17. Jit I, Kulkarni M. Time of appearance and fusion of epiphysis at medical end of clavicle. *Indian J Med Res*. 1976 May; 64(5): 773-82.
18. Knight, Bernard. *Age Estimation: In, Forensic Pathology*, Edward Arnold, A division of Hodder & Stoughton London. 1996; 109-114- 118.

19. Modi PJ. in chapter Personal Identity in Modi's Medical Jurisprudence and Toxicology, 22nd ed. edited by Mathiharan K and Patnaik AK. New Delhi: Butterworths India. 2005; 263-337.
 20. Mehta HS. Age determination-Medical Law and Ethics in India. The Bombay SamacharPvt. Ltd. Mumbai.1963; 335-338 (cited in chapter Personal Identity in Modi's Medical Jurisprudence and Toxicology, 22nd ed. edited by Mathiharan K and Patnaik AK. New Delhi: Butterworths India. 2005; 263-337.
 21. Reddy KSN. Identification-Growth in Individual bone, In the Essentials of Forensic Medicine and Toxicology. 29th ed. Hyderabad: K. Suguna Devi. 2009; 64-71.
-