

## Original Article

### AGE DETERMINATION FROM EPIPHYSEAL UNION OF BONES AT ANKLE JOINT IN GIRLS OF CENTRAL INDIA

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### AGE DETERMINATION FROM EPIPHYSEAL UNION OF BONES AT ANKLE JOINT IN GIRLS OF CENTRAL INDIA

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#### Abstract

There is no statistical data to establish variation in epiphyseal fusion in girls in central India population. This significant oversight can lead to exclusion of persons of interest in a forensic investigation. Epiphyseal fusion of the distal tibia and fibula in sixtyeight females was analyzed 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.

**Key Words:** Epiphyseal Union, Ankle Joint, Distal End of Tibia, Distal End of Fibula

#### Introduction

[1]. Epiphysis of the bones unites at the particular age which are remarkably constant for a particular epiphysis and this is helpful in age determination<sup>[1]</sup>. In law the crime and punishment is entirely based on criminal responsibility and this in turn depend on the age of a person<sup>[2]</sup>. Age is helpful in identification of an individual which in turn is helpful in both civil and criminal cases according to Sangma William Bilkey<sup>[3]</sup>. 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 law courts all over the world<sup>[4]</sup>. 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<sup>[5]</sup>. Parikh CK conclude that Union of epiphysis in cartilaginous bones takes place earlier in the females by about 2 years than in males 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<sup>[6]</sup>. 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<sup>[7]</sup>. 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<sup>[8]</sup>. Jit and Balbir Singh 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<sup>[9]</sup>. 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 assess age specific difference in epiphyseal fusion at ankle Joint in all subjects.
- 2) To estimate age from epiphyseal fusion at ankle joint in all Subjects.
- 3) To compare the findings in the epiphyseal fusion at ankle joint in central Indian population with other part of India on the basis of previous studies.

## Material and Methods

The present study was carried out in Department of Forensic Medicine MGIMS Sewagram Wardha. A total of sixty eight girls participated in this study. The subjects included students of schools, College from Wardha district. The subjects were from 13-20 years of age. An informed consent was taken from all subjects prior to each investigation.

- 1) They are born to parents living in Central India and have lived since birth.
- 2) The subjects do not have any disease/deformity pertaining to bones or chronic disease affecting the general health.

## 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 Kulkarnis classification of four stages, Appearance, Non fusion, Partial fusion, and complete fusion ("NF", "PF", "CF" respectively)<sup>[10]</sup>.

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 in P4 computer using HPSS software. At the end conclusions were drawn which were compared with available results of various previous studies.

## Result

Distal end of Fibula in females shows partial fusion in 2(2.94%) cases in 14-15years of age group. It shows complete fusion in 6(8.82%) cases in 14-15years age group. Similarly it shows complete fusion in all 53(77.95%) cases between 15-20 years of age group except 1(1.47%) case which shows partial fusion in 18-19years of age group.

Distal end of Tibia in females shows partial fusion in 8(11.76%) cases in age group 14-15 years. Shows complete fusion in all 53(77.95%) cases between 15-20 years of age groups. There was exception in 18-19years of age group where only 1(1.47%) case shows partial fusion.



### Photograph 1

1. Lateral View of ankle joint shows Non fusion of distal end of tibia.
2. AP view of ankle joint shows Non fusion of distal end of tibia and fibula

**Table 1:** Percentage of fusion in cases in females

Distal end of Fibula			Distal end of Tibia			
Age in years	NF	PF	CF	NF	PF	CF
13-14	6(8.82%)	0(0.00%)	0(0.00%)	6(8.82%)	0(0.00%)	0(0.00%)
14-15	0(0.00%)	2(2.94%)	6(8.82%)	0(0.00%)	8(11.76%)	0(0.00%)
15-16	0(0.00%)	0(0.00%)	12(17.65%)	0(0.00%)	0(0.00%)	12 (17.65%)
16-17	0(0.00%)	0(0.00%)	10(14.71%)	0(0.00%)	0(0.00%)	10(14.71%)
17-18	0(0.00%)	0(0.00%)	14(20.59%)	0(0.00%)	0(0.00%)	14(20.59%)
18-19	0(0.00%)	1(1.47%)	7(10.29%)	0(0.00%)	1(1.47%)	7(10.29%)
19-20	0(0.00%)	0(0.00%)	10(14.71%)	0(0.00%)	0(0.00%)	10(14.71%)
χ <sup>2</sup> -value	79.43			128.30		
p-value	0.000, S,p<0.05			0.000, S,p<0.05		

### Discussion

Distal end of Tibia in female in 13-14 years of age group shows Non fusion in 6(8.82%) cases. In 14-15 years of age group it shows Partial fusion in all 8(11.76%) cases. The Distal end of Tibia shows complete fusion in all 53(77.95%) cases between 15-20 years of age groups.

**Table 2:** Comparison of age of distal epiphyseal union of tibia in various regions and races with present study

S.N.	Researcher	Region	Age of fusion in females
1.	Davies and Parson (1927) [11].	England	18
2.	Hepworth (1929) [12].	Punjabi	17-18
3.	Flecker (1932) [13].	Australians	14
4.	Pillai (1936)	Madrasis	14-17
5.	Galstaun (1937) [17].	Bengalis	13-15
6.	Basu and Basu (1938) [16].	Hindu (Bengal)	15
7.	Narain and Bajaj(1957)	Uttar Pradesh	17-19
8.	Christian C,(2005) [15].	Mexican Americans	16
9.	Bokariya et al (2009) [14].	Rajasthan	14-15
10.	Present Study	Central India	15-16

Distal end of Fibula in female in 13-14 years of age group shows Non fusion in 6(8.82%) cases. In 14-15years of age group it shows Partial fusion in 2(2.94%) cases and complete fusion in 6(8.82%) cases. The Distal end of Fibula shows complete fusion in all 53(77.95%) cases between 15-20 years of age group.

**Table 3:** Comparison of age of Distal Epiphyseal Union of Fibula in various Regions and Races with present study

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5.	Galstaun (1937)	Bengalis	13-15
6.	Basu and Basu (1938)	Hindu (Bengal)	15
7.	Christian C, (2005)	Mexican American	16
8.	Bokariya et al (2009)	Rajasthan	14-15
9.	Present study	Central India	15-16

### Summary and 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 knee and ankle joint is available involving this particular region of India.
2. The ossification at the ankle joint in females on right side is completed in all instances (100%) at the age of 15-20 year.
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 south India and population of Bengal.
4. By comparing the available literature the age of skeletal maturity in both males and females in this region are nearly similar to those in population of Madhya Pradesh, Uttar Pradesh and Rajasthan.
5. 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.
6. Due to very narrow borderline range of differentiation between various stages of fusion, it is difficult to consider stage of fusion as age indicator.
7. Radiological interpretations are observer dependent so the set standards should be considered under expert guidance to arrive at conclusion in such radiological studies.
8. Along with clinical and dental examination, radiological study plays an important role to arrive at the opinion about the age in Medicolegal cases.
9. 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.

### References

- 1) Aggarwal A. Ages of ossification-Personal Identification in Self Assessment and Review of Forensic Medicine and Toxicology. 1st ed. Delhi: Peepee Publishers and Distributers (P) Ltd.; 2006. p 51-59.
- 2) Srivastav A, Saraswat PK, Agarwal SK, Gupta P: A study of wrist ossification for age estimation in pediatric group in central Rajasthan. JIAFM. 2004; 26(4). ISSN 0971-0973.
- 3) Sangma WB, Marak F K, Singh M.S, Kharrubon B. Age determination in girls of north – eastern region of India JIAFM. 2007; 29(4):102-108. ISSN: 0971-0973.

- 4) Banerjee KK and Aggrwal BB: Estimation of age from epiphyseal union at the wrist and ankle joint in the capital city of India. *Journal of Forensic science International*. 1998; 98: 31-39.
- 5) Modi PJ. Personal identity – ossification of bones, in *Modi's Medical Jurisprudence and Toxicology*. 22nd ed. edited by Subrahmanyam BV. New Delhi Butterworth's India; 1999. 52 – 58.
- 6) Parikh C.K. Personal Identity. *Parikh's Text book of Medical Jurisprudence and Toxicology* 6 th ed. CBS Publishers and distributors; 1996. 2.8-2.14.
- 7) Reddy KSN. Identification-Growth in Individual bone, In the *Essentials of Forensic Medicine and Toxicology*. 29th ed. Hyderabad: K. Suguna Devi; 2009.64-71.
- 8) Mehta H.S. Age determination-Medical Law and Ethics in India. The Bombay Samachar Pvt. Ltd. Mumbai. 1963; p.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: Butterworth's India; 2005. p. 263 – 337)
- 9) Jit I and Singh. B.A radiological study of time of fusion of certain epiphysis in Punjabis. *J Anat. Soc India*. 1971; 20: 1 – 27.
- 10) 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.
- 11) DA and Parsons, F G: The age order of the appearance and union of the normal epiphyses as seen by x-rays. *J. Anat*. 1927, vol. 62:58-71.
- 12) Hepworth SM. Determination of age in Indians from study of the calcification of the long bones. *Ind Med Gaz* 1929; 64:128.
- 13) Flecker H. Time of appearance and fusion of ossification centers. *Am J Roentgenol* 1942; 47: 97–159.
- 14) Bokaria P. Chowdhary DS, Tirpude BH. Age determination in girls of Jodhpur region by epiphyseal union of bone of ankle joint. *Ind Fore med*: 32(1):42-44.
- 15) Crowder C, Austin D. Age range of epiphyseal fusion of in distal tibia and fibula in contemporary males and females. *J for Scie* 2005 :50(5):1-7
- 16) Basu SK and Basu S. A contribution to the study of diaphysio-epiphysial relation at Knee of young Bengali girls. *Ind J of Ped* 1938; 5: 202-204.
- 17) Galstaun G. A study of ossification as observed in Indian subject. *Indian journal of Medical Research* 1937; 25(1):267-324.