

“Age Estimation from Proximal End Fibular Epiphysis in Adolescent Girls: A Radiological Study”

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Abstract

Introduction: There is no statistical data to establish variation in epiphyseal fusion in population of central India. This significant oversight can lead to exclusion of persons of interest in a forensic investigation. **Method:** Epiphyseal fusion of the proximal end of fibula in 68 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 radiological studies. **Results:** By comparing the available literature about ossification of long bones, fusion was delayed by one to three years in this study compared to population of Central India than that of south India and Bengal. By comparing the available literature the age of skeletal maturity in females in this region are nearly similar to those in population of Madhya Pradesh, Rajasthan and Karnataka. **Conclusion:** The ossification at Proximal end of fibula at the Knee joint in Females is completed in all instances (100%) at the age groups of 16-20 year. By comparing the available literature the age of skeletal maturity in females in this region are nearly similar to those in population of Madhya Pradesh, Punjab, Bengal, Rajasthan and Karnataka.

Key Words: Epiphyseal Union, Proximal end of fibula, X ray.

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Introduction:

Epiphysis of the bones unites during age periods which are remarkably constant for a particular epiphysis.¹ Epiphysis of the bones unites at the particular age and this is helpful in age determination. In law the crime and punishment is entirely based on criminal responsibility and this in turn depend on the age of a person.² Age is helpful in identification of an individual which in turn is helpful in both civil and criminal cases

according to Sangma William Bilkeych et al.³ It has been also stated that the study of epiphyseal union of bones is considered a reasonable scientific and accepted method for age determination by the law courts all over the world.⁴ India is a vast country with diversity in social customs, multiple religions, dietary habits and variations in climatic conditions. In Modi's textbook it is quoted that 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.^{5,6} Human growth is continuous process which goes through, first a developmental stage and second, the maintenance of status. In the developmental stage, changes in skeletal and dental

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morphology occur in an age–age predictive sequence.⁷ Reddy KSN stated that (2009) the bones of human skeleton develop from a number of ossification centers. At 11 to 12th week of intrauterine life, there are 806 centers of ossification, at birth there are about 450. The adult human skeleton carries only 206 bones.⁸ 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.⁹ Jit and Balbir Singh revealed that Precocity of epiphyseal union has been attributed to racial and climatic factors. Works in different regions of India-North (Punjab, Delhi and UP), East (Bengal) and South (Chennai) have given different ages of fusion of the epiphysis. Further, workers in the same region have also given different ages of fusion of the epiphysis of the same bone and in the same sex. This difference could possibly be due to inadequate material or recording of incorrect ages of the subjects.¹⁰ It was, therefore, decided to reinvestigate the problem in the central part of India by radiological examination, taking care that adequate material was examined and only those subjects investigated whose ages has been recorded with reasonable degree of accuracy.

This study was confined to the radiological evaluation of the proximal end of fibula to estimate age from epiphyseal fusion of proximal end of fibula in all Subjects, to assess age specific difference in epiphyseal fusion all subjects, and to assess and evaluate the difference in the epiphyseal fusion in Central part of the India with other part of India on the basis of previous studies.

Materials:

The present study was carried out in Department of Forensic Medicine MGIMS Sewagram Wardha. A total of 68 female participated in this study. The subjects included students of schools, College from district. The subjects were from 13-20 years of age group. Approval from ethical

committee and 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.

Methods:

The X-ray films were taken and films were developed with the help of experienced technicians. The part taken for X-ray was Knee for proximal end of Fibula. For the study the X-ray films were divided into three groups for each epiphysis –

Skeletal maturity was evaluated according to the Jits and Kulkarni's classification

1. Those showing No epiphyseal union (NF)
2. Those showing partial union (PF)
3. Those showing complete union (CF)

Data analysis was done in P4 computer using HPSS software.

Results:

Proximal end of Fibula (Table No. 2, 3)

Females: Proximal end of Fibula in females Shows partial fusion in 4(5.88%) cases in 14-15years age group and 5(7.35%) cases in 15-16years of age group. It shows complete fusion in 4(5.88%) and 7(10.29%) cases in 14-15years and 15-16years of age group respectively. Similarly it shows complete fusion in all 42(61.77%) cases between 16-20 years of age groups.

Discussion:

Out of 68 females from age group 13-20years, were studied radiologically for epiphyseal fusion of proximal end of Fibula (TableNo.1).

The proximal end of fibula(TableNo.4)

The findings of proximal end of Fibula in female of present study are in accordance with **Paterson (1929)**¹⁶in the population UK, **Basu and Basu (1938)**²⁰who made their observation in Hindu population. **Saxena and Vyas (1969)**¹²in the population Madhya Pradesh,

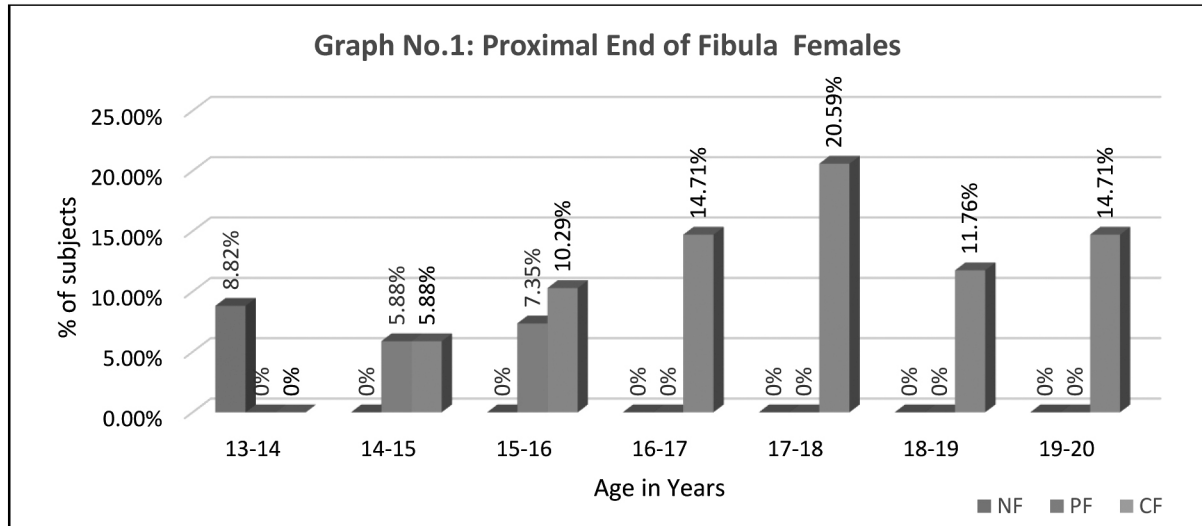


Table 1: Age wise distribution of subjects

Age (in years)	Females	
	No	Percentage
13-14	6	8.82
14-15	8	11.76
15-16	12	17.65
16-17	10	14.71
17-18	14	20.59
18-19	8	11.76
19-20	10	14.71
Total	68	100.00

Table 2: Proximal end of fibula in females

Age (years)	NF	PF	CF	Total
13-14	6(8.82%)	0(0.00%)	0(0.00%)	6(8.82%)
14-15	0(0.00%)	4(5.88%)	4(5.88%)	8(11.76%)
15-16	0(0.00%)	5(7.35%)	7(10.29%)	12(17.65%)
16-17	0(0.00%)	0(0.00%)	10(14.71%)	10(14.71%)
17-18	0(0.00%)	0(0.00%)	14(20.59%)	14(20.59%)
18-19	0(0.00%)	0(0.00%)	8(11.76%)	8(11.76%)
19-20	0(0.00%)	0(0.00%)	10(14.71%)	10(14.71%)
Total	6(8.82%)	9(13.24%)	53(77.94%)	68(100%)
χ^2 -value	92.54			
p-value	0.000, S, $p < 0.05$			

Note: - Figures in parenthesis indicates percentage

S.N.	Researcher	Region	Age of fusion
1	Stevenson (1924)[17]	USA	19
2	Davies and Parson (1927)[11]	England	18-19
3	Hepworth (1929)[21]	Punjabi	16 ½-17 ½
4	Paterson (1929)[16]	UK	16-17
5	Flecker (1932)[15]	Australians	17
6	Pillai (1936)[18]	Madrasis	14-17
7	Galstaun (1937)[19]	Bengalis	14-16
8	Basu and Basu (1938)[20]	Hindu(Bengal)	16-17
9	Saxena and Vyas (1969)[12]	Madhya Pradesh	16-17
10	Connor JE, Bogue C(2008)[22]	Irish	17-17.9
11	Bokariya et al (2009)[13]	Rajasthan	16-17
12	Kausar and Varghese (2011)[14]	Karnataka	17-17 ½
13	Present Study (2013)	Central India	16-17

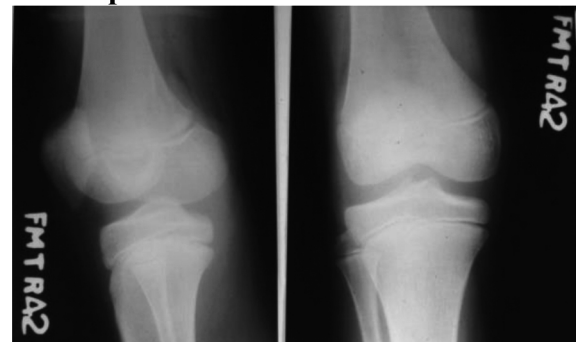
Table 3: Comparison of age of fusion in Proximal Epiphyseal end of Fibula in females

Figure 1: AP view of knee joint shows Partial fusion of proximal end of fibula



Bokaria et al (2009)¹³ in the population of Rajasthan. **Hepworth (1929)²¹** in the population of Punjab and **Flecker (1932)¹⁵** in the population of Australian. Observation of present study also matches with finding of **Kausar, Varghese (2011)¹⁴** in the population of Karnataka and

Figure 2: AP view of knee joint shows Non Fusion proximal end of fibula



Connor JE, Bogue C (2008)²² in the Irish population.

Study of **Pillai (1936)¹⁸** in the population of Madras, **Galstaun (1937)¹⁹** in the population of Bengal, show early fusion by about 1-2 years in proximal end of Fibula.

Summary and Conclusions:

The ossification at Proximal end of fibula at the Knee joint in Females is completed in all instances (100%) at the age groups of 16-20 year. By comparing the available literature the age of skeletal maturity in females in this region are nearly similar to those in population of Madhya Pradesh, Punjab, Bengal, Rajasthan and Karnataka.

Population in Central India is mixed type comprising of various religions and castes. 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. For estimation of age relevant joints should be radiologically examined for different centres and opinion should be arrived considering the status of multiple centers.

Limitations of study

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

Benefits and Implication of Study

- Study will be useful for estimation of age in civil and criminal cases, judicial punishment, Juvenile cases & many other important cases in judicial point of view.
- 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.

Purpose of this study was to define the currently unknown ossification pattern for clinical implication. Conventional radiography remains an essential initial test in the estimation of age from ossification centre.

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