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ORIGINAL ARTICLE

RADIOLOGICAL STUDY OF FUSION OF LOWER END OF FEMUR FOR ESTIMATION OF AGE IN AGRA REGION

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ABSTRACT: Determination of age of an individual whether living or dead, is a vexing problem for a medical expert.[1] Extensive work has been carried out on the theme in different states of India and abroad as well. However, very little work has been reported with reference to Agra population. Present work was undertaken in 200 school going children with known chronological age. In this study lower end of femur fuses at 16-17 years range i.e. average 16.5 years in females and 17-18 years range i.e. average 17.5 years in males. The epiphyseal union in females occurs earlier than male by 1 year.

KEYWORDS: Fusion, femur, radiology, estimation of age.

INTRODUCTION: Extent of ossification and union of epiphysis in bones can be determined in living subjects by the use of 'skiagraphy'. A forensic expert is often required to give opinion regarding the age of person in various civil and criminal cases. According to the existing Indian laws the legal significance of age has been given due consideration in various cases like Indian Railway Act, 1890, Section 83, 87 and 89 IPC, Marriage Contract (child marriage restrain Act 1978), kidnapping (section 369, 361 to 366 A&B), Rape and sexual assault (sec. 375 IPC), Attainment of majority (Indian majority act 1875), Bombay prevention of Bigamous marriage act 1946, Competency of witness (Sec 118 of I.E.A.), infanticide and criminal abortion act.[2]

In civil matters too like eligibility in sports according to various age groups and even nowadays in electronic media various competitions were held whereby only persons of specific age groups can be participated hence the determination of age has paramount importance.

AIMS AND OBJECTIVES:

1. To find out average age of union of epiphysis of lower end of femur in males and females.
2. To find out relation of epiphyseal union to sex.
3. To compare the results of present study with other workers.

MATERIAL AND METHODS: The present study was carried out in the Forensic Medicine and Radiology Department of Sarojini Naidu Medical College, Agra. A total of 200 (100 males, 100 females) in the age group of 10-20 years were selected randomly from various schools of Agra Region. A written informed consent was taken. Right side knee joint is x-rayed with both antero-posterior and lateral view is taken.

Criteria for selecting subjects:

- They should be free from any physical disability or endocrine anomaly.
- Only those cases were taken for the study whose date of birth is verified by their school or college authorities by birth certificate.

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- Written informed consent of the subject was taken before proceeding to their radiological examinations and in case of child below 12 years of age consent of guardian is taken.
- They should be natives of Agra and migrants are excluded from study.

The persons selected for study were grouped as per their stated age, 10-11 years, 11-12 years, 12-13 years, 13-14 years, 14-15 years, 15-16 years, 16-17 years, 17-18 years, 18-19 years, and 19-20 years. This age group 10-11 years is considered as those of who have completed 10 years of age but yet to complete 11 years. Age as stated by them is further confirmed by birth certificate or entry in their school record.

After obtaining written consent for their radiological examination each person is x-rayed for Right side elbow joint. Anteroposterior and Lateral view of the skiagrames are studied in X-ray view box in detail in reference to fusion of epiphysis at lower end of femur.

Stages of epiphyseal union:

The process of epiphyseal union is divided into four stages:

According to Kangne and others[3]:

Stage 1- No union: Complete gap or space between the epiphysis and shaft of the bone.

Stage 2-Partial union: Partial closure of gap or space.

Stage 3-Recent union: Closure of gap or space but a thin line visible at epiphysio-diaphyseal junction.

Stage 4- Complete Union: Epiphyseal space bony in architecture.

For practical purposes stage 1 and 2 considered as not fused and similarly stage 3 and 4 were considered as fused. For generalization fusion in more than 75% cases in any age group is relied upon as age of complete fusion. That age becomes taken as the age of fusion. For the study X ray films were divided into two groups for each epiphysis:

1. Those showing complete union.
2. Those showing non-union.

OBSERVATIONS: Determination of age of fusion of epiphysis of lower end of femur was observed in skiagrames of 200 subjects of Agra region of Uttar Pradesh. In present work 100 females and 100 males of various authentically known age groups were selected. These cases were distributed between 10 to 20 years of age.

The following table shows the total number of cases selected for study in different age groups.

Age Group	No. of Males Examined	No. of Females Examined	Total
10 – 11	5	4	9
11 – 12	5	4	9
12 – 13	6	5	11
13 – 14	8	10	18
14 – 15	18	15	33
15 – 16	12	20	32
16 – 17	12	10	22
17 – 18	12	12	24

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18 – 19	10	12	22
19 – 20	12	8	20
Total	**100**	**100**	**200**

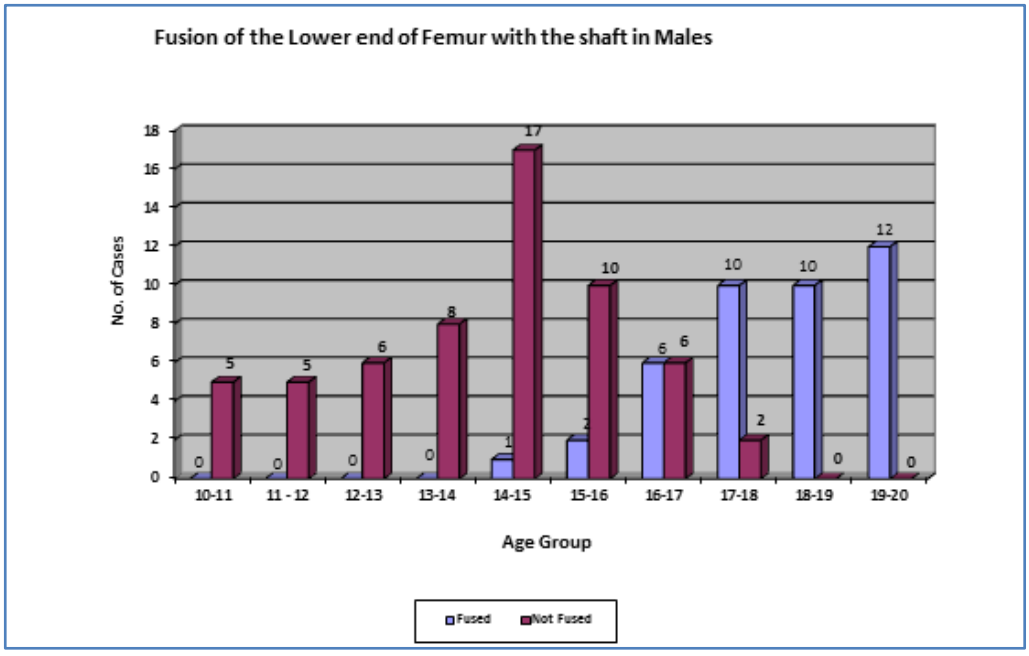
Table No. 1: Distribution of study Subjects According to Sex

Age Group	No. of Cases examined	Fused	%	Not fused	%
10 – 11	5	0	0.00	5	100.0
11 – 12	5	0	0.00	5	100.0
12 – 13	6	0	0.00	6	100.00
13 – 14	8	0	0.00	8	100.00
14 – 15	18	1	5.56	17	94.44
15 – 16	12	2	16.67	10	83.63
16 – 17	12	6	50.00	6	50.00
17 – 18	12	10	83.33	2	16.67
18 – 19	10	10	100.0	0	0
19 – 20	12	12	100.0	0	0
Total	**100**	**41**		**59**	

Table No. 2: Showing fusion of the Lower End of Femur with the shaft in Males.

In males the earliest fusion was seen in a boy of at the age of 14 years 8 months and the oldest boy showed fusion at the age of 17 years 10 months 4 days. The lower end of femur fuses with shaft in majority of cases in 17 – 18 years (83.33%).

The range of epiphyseal fusion was seen in 14 – 18 years. The 100% fusion of epiphysis was from the age group of 18 – 19 years.



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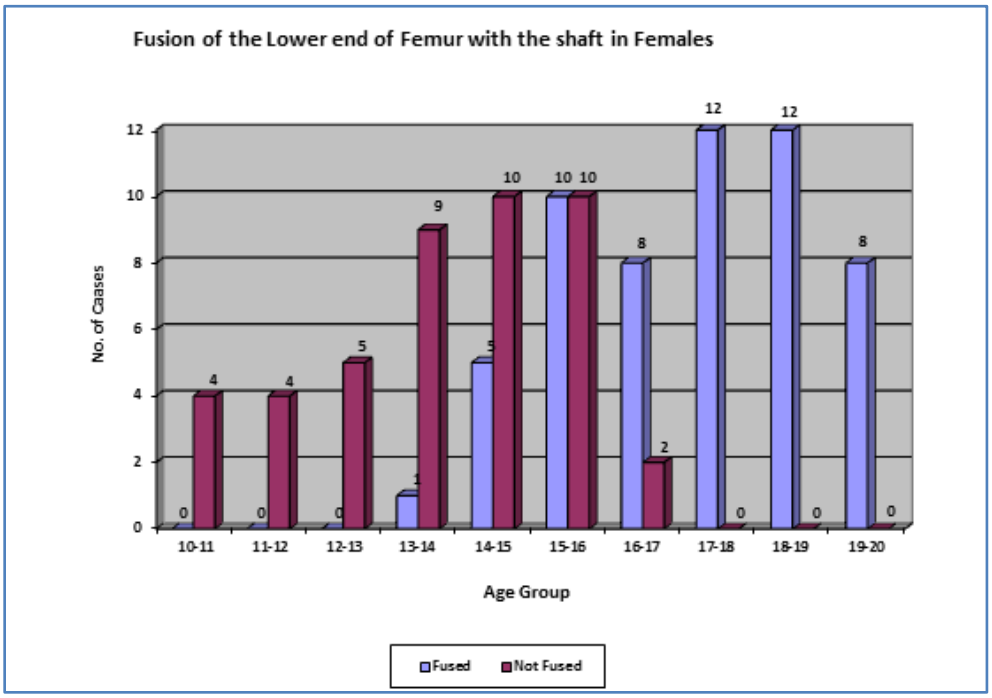

Age Group	No. of Cases examined	Fused	%	Not fused	%
10 – 11	4	0	0.00	4	100.00
11 – 12	4	0	0.000	4	100.00
12 – 13	5	0	0.00	5	100.00
13 – 14	10	1	10.00	9	90.00
14 – 15	15	5	33.33	10	66.67
15 – 16	20	10	50.00	10	50.00
16 – 17	10	8	80.00	2	20.00
17 – 18	12	12	100.00	0	0.00
18 – 19	12	12	100.00	0	0.00
19 – 20	8	8	100.00	0	0.00
Total	100	56		44	

Table No. 3: Showing fusion of the Lower End of Femur with the shaft in Females.

The earlier fusion of distal epiphysis of femur with the shaft was seen in a girl at the age of 13 years 10 months 2 days while oldest girl showed fusion at the age of 17 years 8 months 2 days. In majority of females the fusion was noticed at the age of 16 – 17 years (80%) and 100% fusion from the age of 17 – 18 years. The range of fusion was between the 13 – 17 years.

EPIPHYSIS	Mean Age		Mean S.D.		t value	p value
	MALE	FEMALE	MALE	FEMALE		
Lower end of femur with shaft	18.01	17.16	1.309	1.618	2.770	< 0.05

Table No. 4: Comparison of Mean Age of Fusion between Males and Females

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In all the epiphysis mean age of fusion is higher in males as compared to females. Difference in age of fusion between males and females is statistically significant.

DISCUSSION: In the present work average age for union of lower end of femur with shaft is 16.5 years, and 17.5 years in females and males respectively. Aggarwal M.L, and Pathak I.C.[4] (1956, Punjab) have found epiphyseal union at lower end of femur age of 14½ - 16½ years in females. These findings differ from our study by one year, in this study females show fusion earlier by 1 year.

Saxena J. S, Vyas S. K.[5] (Madhya Pradesh, 1969) and Banerjee K. K, Aggarwal B.B.L.[6] (1997, Delhi) found epiphyseal union of lower end of femur at age of 16 – 17 years and 18 – 19 years in females and males respectively. These findings are indicative that in females age of fusion is similar to present study but in males age of fusion differs by 1 year and it occur later than present study.

Difference is due to as Saksena J.S, Vyas S.K. taken the age group showing fusion of 85% as the criteria for age of fusion and in present study the criterion taken for fusion of age at which 75% is showing fusion.

Workers	Subject	Females (Age in years)	Males (Age in years)
Indian (Other state than UP)			
Aggarwal M.L, Pathak, I.C.	Punjab	14½ - 16½	-
Saxena, J.S, Vyas S.K,	Madhya Pradesh	16 – 17	18 – 19
K.K. Banerjee, B.B.L. Aggarwal	Delhi	16 – 17	18 – 19
Dr. Sangama, Dr. Marak, Dr. Singh M and Dr. Kharrubon Biona	A.P., Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura	17	-
U.P. workers			
G.S. Mittal	UP	16 – 17	17 – 18
Das Gupta S.M. Prasad Vinod, Singh Shamer	UP	17 – 18	18 – 19
Present Series	UP	16 – 17	17 – 18

Table no. 5 showing fusion of lower end of femur with shaft by different workers.

Mittal G.S. [7] (1952, U.P.) has found epiphyseal union at lower end of femur at age of 16 – 17 years and 17 – 18 year in females and males respectively. His findings are similar with present study.

Das Gupta S.M, Prasad Vinod, Singh Shamer[8] (1974, U.P.**)** have found epiphyseal union at lower end of femur at age of 17 – 18 and 18 – 19 in females and males respectively. These findings are higher by 1 year in both males and female. Difference in the methods used for staging the epiphyseal union & difference in selecting the criteria for generalization, may play a role in the variations of results & observations of various workers.

In all the epiphysis mean age of fusion is higher in males as compared to females. Difference in age of fusion between males and females is statistically significant.

The observation was made after comparing the radio-graphs of females and males of the same age group as well as radiographs having similar stages in union. Former was showing the union

ahead in the female series while in the later the male was elder than that of female. These finding are similar with the finding of Banerjee KK, Aggarwal BBL.

RESULTS: The epiphyseal union in females occurs earlier than males by 1 year. This is in consonance with various observations that in long bones females show fusion earlier than male.[9, 10, 11] From the study, it is seen that the time of fusion of the epiphysis around the lower end of femur studied are more or less the same with majority of the workers except few.

Precise age of candidate cannot be stated, but a range can be given by radiological assessments. It is not possible to make any hard and fast rule for the estimation of age from epiphyseal union for the whole of India, because India is composed of areas which differ in climatic, hereditary, dietetic and other factors. Furthermore only radiological factor is not the sole indicator for determination of age but age may be concluded in the light of physical and dental examination.

We recommend further study of larger geographical area and statistic tests for near scientific opinion in age assessment cases.

REFERENCES:

1. Kangne RN, Sami SA, Deshpande VL. Age estimation of adolescent females by radiography. JFMT 1999; 16 (1): 20-26.
2. Modi. Medical jurisprudence and toxicology, 23rd edition.2009, p 285 – 307.
3. Kangne RN, Sami SA, Deshpande VL. Age estimation of adolescent females by radiography.JFMT.1999; 16 (1): 20-26.
4. Aggarwal ML, Pathak IC. Roentgenologic study of epiphyseal union in Punjabi females for determination of age. Ind Jour Med Res. 1957; 45 (2): 285-289.
5. Saxena JS, Vyas SK. Epiphyseal union at the wrist, knee and iliac crest in residents of Madhya Pradesh. J Indian M A. 1969; 53 (2): 67-68.
6. Banerjee KK, Aggarwal BBL. Roentgenologic study of epiphyseal union at the lower end of Humerus and femur bone in Delhi. Journal of Indian Academy of Forensic Medicine.1997; 19 (1): 26-8
7. Mittal GS. Epiphyseal union in long bones its significance in age estimation. Thesis for MD Lucknow University, 1952.
8. Das Gupta SM. A roentgenologic study of epiphyseal union around elbow, wrist and knee joint and the pelvis in males and females of Uttar Pradesh. J Indian M A 1974; 62 (1):10-12.
9. Schmidt S, Koch B, Schulz R, Reisinger W, Schmeling A. Comparative analysis of the applicability of the skeletal age determination methods of Greulich-Pyle and Thiemann-Nitz for Forensic age estimation in living subjects. Int J Leg Med. 2007; 121 (4): 293-296.
10. Krogman W M, Iscan M Y. The human skeleton in Forensic Medicine.2nd edition. Illinosis: Charles C. Thomas; p.64.
11. Reddy KSN. The Essentials of Forensic Medicine and Toxicology, 27th edition, K.Saguna Devi: Hyderabad, 2008: 64-74.

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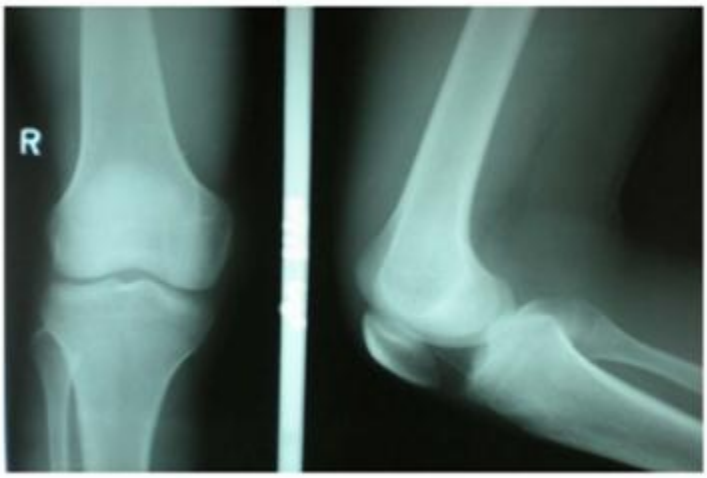

Figure 18 Years 2 months female AP and Lateral view of right knee joint showing fusion of lower end of femur

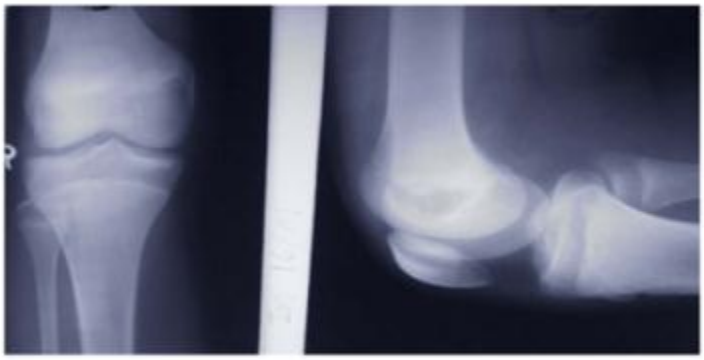

Figure 14 : 16 Years 4 months male AP and Lateral view of right knee joint showing partial fusion of lower end of femur.

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