

Original article:

To Assess the Average Age of Fusion of Ossification Centre of Lower End of Femur, Upper End of Tibia & Fibula, For a Known Chronological Age in Subjects of Bikaner Region

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Abstract:

Background: The assessment of age in living individuals by a forensic anthropologist will by necessity involve radiographic imaging. The appearance and fusion of some centers in the bones with others of the same bones form the basis of estimation of age. Age of epiphyseal union is an important objective method of age determination. But these ages varies with racial, geographic, climatic and various other factors. These variations have suggested need of separate standards of ossification for separate regions.

Materials & Methods: This study was carried out in the Department of Forensic-Medicine and Toxicology in association with Radio-diagnosis Department of S.P. Medical College and A.G. of Hospital, Bikaner. The total number of subjects (n= 80) was selected randomly from various schools, from neighbourhood of various faculty members and staff as well as cases attending the OPD. The subjects selected for study was grouped as per their stated age, viz.: -14-15years, 15-16years, 16-17years, 17-18years, 18-19years, 19-20years, 20-21years, 21-22years, 22-23years and 23-24 years. Finally the details were analyzed and the conclusions were drawn after comparing and discussing with similar type of the work carried out by foreign and Indian authors.

Results & Conclusion: Our study showed that average age of fusion of the ossification centre of lower end of femur at 16-18 yrs in girls & 17-19 yrs of age in boys. The fusion of the ossification centre of upper end of tibia at 16-19 yrs and upper end of fibula at 17-20 yrs in girls & boys.

Keywords: Ossification Centre, Femur, Tibia, Fibula, Epiphysis.

INTRODUCTION

Age is one of a number of biological attributes a forensic anthropologist will assess in the skeleton towards providing an osteobiography; the remaining elements are sex, stature, ancestry, as well as an assessment of trauma and pathology.¹ An osteobiography provides important information to investigative authorities towards identifying the individual being assessed.² A forensic anthropologist will also frequently employ medical modalities (such as radiography) to visualise skeletal structures, especially in living individuals for the specific purpose of assessing legal minority and/or culpability.³

The assessment of age in living individuals by a forensic anthropologist will by necessity involve radiographic imaging.⁴ There is a preference for age estimation techniques that subject the individual being assessed to the least

amount of radiation, while maintaining accuracy and minimizing invasiveness.⁵ While the methods for assessing age in living individuals vary depending on the region of the skeleton being assessed, they can also be applied to skeletal remains, as they are based on the assessment of skeletal growth and development as described in published age estimation standards.⁶

Determination of age is helpful in both civil and criminal cases. In the living age determination is the most important issue to the court and to the common citizens as well. It is essential to establish the identity of the person at the time of admission to schools, colleges, institutes, or while competing in sports tournaments at regional, state or national levels. It is also important while taking consent or in cases relating to juvenile offenders, rape, kidnapping, employment in Govt. establishments, competency as a witness, attainment of majority, marriage, fixation of criminal responsibility, etc.⁷

There are hundreds of ossification centers in the bones of the body. The appearance and fusion of some centers in the bones with others of the same bones form the basis of estimation of age. The long bones of lower limb play a vital role in assessment of age both in living and dry remains.⁸

Age is an important parameter for medico-legal cases. Many times, doctors are called upon to give opinion about age of a person. For these objective methods of age determination are required. Age of epiphyseal union is an important objective method of age determination. But these ages varies with racial, geographic, climatic and various other factors. These variations have suggested need of separate standards of ossification for separate regions.

MATERIALS & METHODS

This study was carried out in the Department of Forensic-Medicine and Toxicology in association with Radio-diagnosis Department of S.P. Medical College and A.G. of Hospital, Bikaner. The total number of subjects (n= 80) was selected randomly from various schools, from neighbourhood of various faculty members and staff as well as cases attending the OPD of P.B.M. & AG Hospitals, Bikaner. The age of subjects was determined by fusion of ossification centre of knee joint by Anteroposterior & lateral views of digital X- Rays.

Method for X-ray Examination

Study was carried out by Digital technique. The technique included standardization of

1. Time of exposure
2. Positioning of the part
3. Distance from film and X-Ray tube
4. Processing and time of developing the films.

Positioning of Knee during X-Ray

The knee region was ski graphed for the AP view with joint fully extended and slightly flexed for the lateral view of knee.

Selection Criteria for Inclusion of Person in Present Study

For selection of subjects, following facts were recorded and considered:

1. They should be living in Bikaner region for more than 5 years.
2. They should be free from any physical disability or endocrinal anomaly.
3. Person should have accurate record of their date of birth.

Exclusion Criteria

- Subjects with musculo-skeletal disorder, fractures at the joint, nutritional disorders and chronic illness will be excluded from the study.
- Age <14 years or >24 years will be excluded from the study.

The subjects selected for study was grouped as per their stated age, viz.:-14-15years, 15-16years, 16-17years, 17-18years, 18-19years, 19-20years, 20-21years, 21-22years, 22-23years and 23-24 years.

Age as stated by them was further confirmed by secondary school certificate, any document reflecting their exact age viz Birth certificate, or entry in their school record. The persons belonging to the age group selected for the study of either gender are included in the study irrespective of their socioeconomic, religious and educational status, each person so chosen on the basis of criteria as mentioned above are evaluated clinically in details as per Performa.

Criteria for Data Analysis of Fusion of Ossification Centers Were

1. Stage I: Centre has appeared but there is no union: +
2. Stage II: Union has started but there is incomplete union: ++
- 3 Stage III: Recent union, here there is a complete union between the epiphysis and diaphysis. The diaphyseo-epiphyseal union is complete with persistence of white lines termed as epiphyseal scar at the site of fusion of epiphysis with diaphysis. : +++
4. Stage IV: Old union, here there is a complete union between the epiphysis and diaphysis, with the disappearance of epiphyseal scar: ++++

Finally the details were analyzed and the conclusions were drawn after comparing and discussing with similar type of the work carried out by foreign and Indian authors.

Table 1: Age wise distribution of subjects according to fusion between epiphysis and diaphysis in lower end of femur in males & females

Age group	Stage I		Stage II		Stage III		Stage IV	
	Male	Female	Male	Female	Male	Female	Male	Female
14-15 yrs	2(100%)	3 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
15-16 yrs	6(100%)	0 (0%)	0 (0%)	2 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
16-17 yrs	0 (0%)	0 (0%)	5 (100%)	4 (80%)	0 (0%)	1 (20%)	0 (0%)	0 (0%)
17-18 yrs	0 (0%)	0 (0%)	3 (37.5%)	0 (0%)	5(62.5%)	5 (100%)	0 (0%)	0 (0%)
18-19 yrs	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (60%)	1 (33.3%)	2 (40%)	2(66.6%)
19-20 yrs	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (60%)	0 (0%)	2 (40%)	4 (100%)
20-21 yrs	0 (0%)	0 (0%)	0 (0%)	0 (0%)	2 (33.33%)	0 (0%)	4(66.6%)	3 (100%)
21-22 yrs	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	5 (100%)	3 (100%)
22-23 yrs	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (100%)	3 (100%)
23-24 yrs	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (100%)	1 (100%)
Total	8	3	8	6	13	7	19	16

Table 2: Age wise distribution of subjects according to fusion between epiphysis and diaphysis in Upper end of Tibia in males & females

Age group	Stage I		Stage II		Stage III		Stage IV	
	Male	Female	Male	Female	Male	Female	Male	Female
14-15 yrs	2 (100%)	3 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
15-16 yrs	4(66.6%)	0 (0%)	2 (33.3%)	2 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
16-17 yrs	0 (0%)	0 (0%)	3 (60%)	3 (60%)	2 (40%)	2 (40%)	0 (0%)	0 (0%)
17-18 yrs	0 (0%)	0 (0%)	1 (12.5%)	1(20%)	7 (87.5%)	4 (80%)	0 (0%)	0 (0%)
18-19 yrs	0 (0%)	0 (0%)	0 (0%)	0 (0%)	4 (80%)	1(33.3%)	1 (20%)	2(66.6%)
19-20 yrs	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (60%)	0 (0%)	2 (40%)	4 (100%)
20-21 yrs	0 (0%)	0 (0%)	0 (0%)	0 (0%)	2(33.3%)	0 (0%)	4(66.6%)	3 (100%)
21-22 yrs	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	5 (100%)	3 (100%)
22-23 yrs	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (100%)	3 (100%)
23-24 yrs	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (100%)	1(100%)
Total	6	3	6	6	18	7	18	16

Table 3: Age wise distribution of subjects according to fusion between epiphysis and diaphysis in Upper end of fibula in males & females

Age group	Stage I		Stage II		Stage III		Stage IV	
	Male	Female	Male	Female	Male	Female	Male	Female
14-15 yrs	2 (100%)	3 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
15-16 yrs	6 (100%)	1 (50%)	0 (0%)	1(50%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
16-17 yrs	2 (40%)	0 (0%)	3 (60%)	4 (80%)	0 (0%)	1(20%)	0 (0%)	0 (0%)
17-18 yrs	0 (0%)	0 (0%)	7 (87.5%)	1 (20%)	1 (12.5%)	4 (80%)	0 (0%)	0 (0%)
18-19 yrs	0 (0%)	0 (0%)	1 (20%)	0 (0%)	4 (80%)	1 (33.3%)	0 (0%)	2(66.7%)
19-20 yrs	0 (0%)	0 (0%)	0 (0%)	0 (0%)	4 (80%)	2 (50%)	1 (20%)	2 (50%)
20-21 yrs	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (50%)	0 (0%)	3 (50%)	3 (100%)
21-22 yrs	0 (0%)	0 (0%)	0 (0%)	0 (0%)	2 (33.3%)	0 (0%)	3 (66.6%)	3 (100%)
22-23 yrs	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (100%)	3 (100%)
23-24 yrs	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (100%)	1(100%)
Total	10	4	11	6	14	8	13	14

Table 4: Comparison of different studies done by various workers

S. No.	Authors	Region	Lower End of Femur		Upper End of Tibia		Upper End of Fibula	
			M	F	M	F	M	F
1	Present Study	Bikaner	17-19	16-18	16-19	16-19	17-20	16-19
2	Davies and Parson (1927) ¹⁰	England	19	19	19	19	18-19	18-19
3	Paterson (1929) ¹¹	U.K.	14-17	14-17	18	16-17	18	16-17
4	Todd (1930) ¹²	U.S.A.	17.5-18.5	17.5-18.5	17.5-18.5	17.5-18.5	18	16-17
5	Flecker (1932) ¹³	Australian	19	17	18	-	19	17
6	Pillai (1936) ¹⁴	Madras	14-17	14-17	14-17	14-17	14-17	14-17
7	Galstaun (1937) ¹⁵	Bengalis	14-17	14-17	15-17	14-15	11-19	14-16
8	Basu and Basu (1938) ¹⁶	Hindu	-	16	15-16	15-16	16-17	16-17
9	Saxena and Vyas (1969) ¹⁷	Madhya Pradesh	18-19	18-19	18-19	16-17	18-19	16-17
10	Das Gupta et al (1974) ¹⁸	Uttar Pradesh	18-19	16-17	18-19	17-18	-	-
11	Bokariya et al (2011) ¹⁹	Rajasthan	18-19	16-17	17-18	14-15	18-19	16-17
12	Sangma William ²⁰	North-East India	17	17	17	17	17	17
13	Kausar Asma ²¹	Bijapur	18-18.5	16-16.5	17.5-18	16-16.5	18.5-19	17-17.5
14	K.S.N. Reddy ²²		18-19	18-19	18-19	18-19	18-19	18-19
15	Apurba Nandy ²³		16-17	15-16	16-17	15-16	14-16	14-16
16	V.V.Pillay ²⁴		18-19	18-19	18-19	18-19	18-19	18-19

S. No.	Authors	Region	Lower End of Femur		Upper End of Tibia		Upper End of Fibula	
17	Biswas Gautam ²⁵		17-18	17-18	17-18	17-18	17-18	17-18

RESULTS

Our study showed that average age of fusion of the ossification centre of lower end of femur at 16-18 yrs in girls & 17-19 yrs of age in boys (table 1). The fusion of the ossification centre of upper end of tibia at 16-19 yrs (table 2) and upper end of fibula at 17-20 yrs in girls & boys (table 3).

DISCUSSION

Age as stated by them was further confirmed by secondary school certificate, any document reflecting their exact age viz Birth certificate, or entry in their school record. The persons belonging to the age group selected for the study of either gender are included in the study irrespective of their socioeconomic, religious and educational status, each person so chosen were evaluated clinically in details as per Performa.

Our study showed the maximum number of cases belongs to 17-18 years of age group in both genders in urban residency and 16-17 & 20-21 years of age group in rural residency in both genders. Similar study done by Apurba Nandy (2010)⁹ stated that countable differences are noticed in the appearance and fusion activities of ossification centres depending on race, geographic distribution and sex. The process of ossification may also be influenced by food habit, nutritional status, infectious diseases, hormonal and metabolic disorders, and physical activities. The ages of union of epiphyses in females were found to be earlier by about a few months to two years on the whole by many workers and are quiet understandable taking in to consideration the earlier onset of puberty in the females.

Our findings compare with various workers as summarized as table no. 4.

CONCLUSION

We concluded that average age of fusion of the ossification centre of lower end of femur at 16-18 yrs in girls & 17-19 yrs of age in boys (table 1). The fusion of the ossification centre of upper end of tibia at 16-19 yrs (table 2) and upper end of fibula at 17-20 yrs in girls & boys

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