Forensic Age Estimation from Proximal End of Femur: A Radiological Study in Living Individuals

Ninad Nagrale[1], Swapnil Patond[2], Ranjit Ambad[3], Nandkishor Bankar[4], Karan Jain[5]

[1]Associate Professor, Department of Forensic Medicine, Datta Meghe Medical College, Nagpur (MS), [2]Associate Professor, Department of Forensic Medicine, Jawaharlal Nehru Medical College, DMIMS, Wardha (MS), [3]Associate Professor, Department of Biochemistry, Datta Meghe Medical College, Nagpur (MS), [4]Associate Professor, Department of Microbiology, Datta Meghe Medical College, Nagpur (MS), [5]Tutor, Department of Community Medicine, Datta Meghe Medical College, Nagpur (MS)

Abstract

Age determination is a very essential work in the field of forensic anthropology, which is a scientific study of human skeleton to determine age, sex and time of death to identify an individual. The identification is nothing but the recognition of an individual through various physical features or biological parameters. This study aims to examine the relationship between the stage of epiphyseal union of ossification centres at proximal end of femur & biological age in Chhattisgarh population. The study was carried out in 140 healthy subjects (70 girls and 70 boys) aging from 13 to 20 years. The obtained results revealed that the complete fusion of epiphysis of proximal end of femur is seen at 17-19 years. Females were consistently developing epiphysealunion at a younger age than their male counterparts with one year of difference. Results also suggest that the age of epiphyseal fusion at proximal end of femur is found to vary greatly all over the India, indicating the need for separate standards for separate regions.

Keywords: *Epiphyseal Union, Head of femur, Greater trochanter, Lesser trochanter.*

Introduction

Age determination by the epiphyseal fusion of bones is an intrinsic part of the biological characteristics by a forensic anthropologist to assist in achieving the identification of an individual. There are many well-known variables for identification of an individual like birthmarks, mal-formations, tattoo marks, scar marks etc. These types of identification are done by the forensic anthropologist. Several decomposed, burned, mutilated bodies are difficult to recognise & hence the identification of an individual becomes difficult[1,2]. Forensic anthropologist plays a crucial role in age determination & is one of the stringent problems in the medical justice system in both civil & criminal matters. As age advances, it becomes a wide problem in view of factors like nutrition, heredity, race, endocrinal etc. By taking into account the radiological analysis, this study will be of great help in further understanding the details of accurate assessment of age in Central Indian population[3,4,5].

Aims and Objectives:

1. To evaluate age specific difference in epiphyseal union at proximal end of femur.
2. To estimate age from epiphyseal union at proximal end of femur.
3. To compare bisexual difference in epiphyseal union at proximal end of femur.
4. To compare the findings of epiphyseal union at proximal end of femur in Central Indian population with other parts of India on the basis of previous studies.

Corresponding Author:
Dr. Swapnil Patond
Associate Professor, Department of Forensic Medicine, Jawaharlal Nehru Medical College, DMIMS, Wardha (MS)

Material and Method

The present study was carried out in the Department of Forensic Medicine & Department of Radiology, SSIMS, Bhilai, Chhattisgarh. A total of 150 individuals participated in this study. The subjects included were students of 13-20 years of age from schools & colleges from Bhilai & Durg city. They are born to parents domicile from Central India & have lived here since birth. The subjects do not have any disease/deformity related to bones or chronic disease affecting the general health. An informed consent was taken from all subjects prior to each procedure. Skeletal maturity was evaluated according to the Jit & Kulkarni's classification[1] of four stages: Appearance, Non fusion, Partial fusion & Complete fusion. X-Rays showing clear gap between the epiphyseal and diaphysial ends & showing saw tooth like appearance end were designated as "Non-fusion" (NF) X-rays. X-Rays showing a line replacing the hiatus between the epiphyseal & diaphysial ends & 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 & showing scar of the previous stage were designated as "Complete Fusion" (CF). It was classified, analysed and compared with known standards. At the end conclusions were drawn, which were compared with available results of various previous studies.

Results

Table 1: Epiphyseal fusion in males:

Age (years)	Head of femur			Greater trochanter			Lesser trochanter		
	NF	PF	CF	NF	PF	CF	NF	PF	CF
13-14	3	7	0	4	6	0	3	7	0
14-15	1	9	0	2	8	0	1	9	0
15-16	0	10	0	1	9	0	1	9	0
16-17	0	8	2	0	8	2	0	8	2
17-18	0	4	6	0	3	7	0	4	6
18-19	0	0	10	0	0	10	0	0	10
19-20	0	0	10	0	0	10	0	0	10
Total	**70 (100%)**			**70 (100%)**			**70 (100%)**		

Table 2: Epiphyseal fusion in females

Age (years)	Head of femur			Greater trochanter			Lesser trochanter		
	NF	PF	CF	NF	PF	CF	NF	PF	CF
13-14	0	10	0	0	10	0	0	10	0
14-15	0	9	1	0	8	2	0	9	1
15-16	0	7	3	0	7	3	0	7	3
16-17	0	2	8	0	1	9	0	2	8
17-18	0	0	10	0	0	10	0	0	10
18-19	0	0	10	0	0	10	0	0	10
19-20	0	0	10	0	0	10	0	0	10
Total	**70 (100%)**			**70 (100%)**			**70 (100%)**		

In males, Head of femur shows: non fusion in 4 (5.71%) cases in age group of 13-15 years, partial fusion in 38(54.28%) cases in age group of 13-18 years & complete fusion in 28 (40%) cases in age group of 16-20 years. Complete fusion is seen in all the subjects in age group of 18-20 years. In females, Head of femur

shows: partial fusion in 28 (40%) cases in age group of 13-17 years & complete fusion in 42 (60%) cases in age group of 14-20 years. Complete fusion is seen in all the subjects in age group of 17-20 years.

In males, Greater trochanter shows: non fusion in 7 (10%) cases in age group of 13-16 years, partial fusion in 34 (48.57%) cases in age group of 13-18 years & complete fusion in 29 (41.43%) cases in age group of 16-20 years. Complete fusion is seen in all the subjects in age group of 18-20 years. In females,Greater trochanter shows: partial fusion in 26 (37.14%) cases in age group of 13-17 years & complete fusion in 44(62.85%) cases in age group of 14-20 years. Complete fusion is seen in all the subjects in age group of 17-20 years.

In males, Lesser trochanter shows: non fusion in 5 (7.14%) cases in age group of 13-16 years, partial fusion in 37 (52.86%) cases in age group of 13-18 years & complete fusion in 28 (40%) cases in age group of 16-20 years. Complete fusion is seen in all the subjects in age group of 18-20 years. In females, Lesser trochanter shows: partial fusion in 28 (40%) cases in age group of 13-17 years & complete fusion in 42 (60%) cases in age group of 14-20 years. Complete fusion is seen in all the subjects in age group of 17-20 years.

Discussion

Table 3: Comparison of Age of union (years)

Sr. No	Researcher	Region/population	Union of head, greater trochanter & lesser trochanter with shaft of femur (years)	
			Male	Female
1	Davies & Parson[2]	England	19-20	19-20
2	Hepworth[3]	Punjabi	15.5 - 17	15.5 - 17
3	Flecker[4]	Australians	17	14
4	Galstaun[5]	Bengalis	16-19	14-15
5	Chaurasia[6]	Indian	17-18	17-18
6	Parikh[7]	Indian	16 - 18	16 - 18
7	Nandy[8]	Indian	16 - 17	14 - 15
8	Vij[9]	Indian	17 - 18	17 - 18
9	Bhise S et al[10]	Mumbai	16 - 18	14 - 16
10	Sharma Y et al[11]	Udaipur	18-19	18-19
11	Devraj N et al[12]	Dhule	-	17-18
12	Present Study	Central India	18-19	17-18

When we compare our study with the previous studies for female population we found that our study is in agreement with studies conducted by Chaurasia[6], Parikh[7], Vij[9], Sharma Y et al[11] & Devraj N et al[12]. Whereas for male population we found that our study is in agreement with studies conducted by Galstaun[5], Chaurasia[6], Parikh[7], Vij[9], Bhise S et al[10] & Sharma Y et al[11]. If we carefully go through the above chart and analyse the overall age range for the Union of head, greater trochanter & lesser trochanter with shaft of femur, we found out that there is a lot of regional variation. So address this problem there is immense need of such studies in different regions of our country & these studies must include larger sample size.

Summary and Conclusion

1. This study was conducted exclusively on the young indigenous population of Central India.
2. The epiphyseal union at proximal end of femur in males is completed in all instances (100%)at the age of 18-19 years.
3. The epiphyseal union at proximal end of femur in females is completed in all instances (100%) at the age of 17-18 years.

4. Females were consistently developing epiphysealunion at a younger age than their male counterparts, with one year of difference.
5. Central Indian population is of mixed type comprising of various religions and castes. The opinion about age should always be given in the range.
6. From this study, range of 1-2 years of margin of error can be concluded.
7. For age estimation, relevant joints should be radiologically examined for different centres and opinion should be arrived considering the status of multiple centres.

Ethical Clearance: Taken from institutional ethics committee.

Source of Funding: Self.

Conflict of Interest: Nil.

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