

Radiological Evaluation of Innominate Bone for Age Estimation: A Cross Sectional Study from Central India

Ninad Nagrale¹, Swapnil Patond², Ranjit Ambad³, Nandkishor Bankar³, Karan Jain⁴

¹Associate Professor, Department of Forensic Medicine, Datta Meghe Medical College, Nagpur (MS),

²Associate Professor, Department of Forensic Medicine, Jawaharlal Nehru Medical College, DMIMS, Wardha

(MS), ³Associate Professor, Department of Biochemistry, Datta Meghe Medical College, Nagpur (MS), ⁴Tutor,

Department of Community Medicine, Datta Meghe Medical College, Nagpur (MS)

Abstract

Age is cardinal in both civil & criminal cases as it not only affects the way an individual is treated, both in court and with regards to bail, but it also influences the defence under Indian Penal system. The defence for children is easier to establish than that for an adult. This study focuses on investigating the relationship between the stage of fusion of secondary ossification centres of innominate bone & biological age in Chhattisgarh population. This study was carried out in 140 healthy subjects (70males and 70 females) aging from 17 to 24 years. The obtained results revealed that the complete fusion of both epiphyses of innominate bone is seen at 21-22 years. Comparatively, females were developing epiphysealunion at a younger age than their male counterparts. Results also suggest that the age of epiphyseal fusion at iliac crest & ischial tuberosity is found to vary greatly all over the India, indicating the need for separate standards for separateregions.

Keywords: Epiphyseal union, iliac crest, ischial tuberosity, innominate bone.

Introduction

Evaluation of age by radiological study of union of ossification centers is helpful to solve many civil & criminal cases like capital punishments, sexual offences, abductions, kidnappings, matrimonial disputes, contract agreements, consent for medical examination, admission & eligibility for various institutions etc. Also, age determination at the time of death is of supreme importance for identification purpose. It is also true for bio archaeological studies, where the reconstruction of health and disease patterns or demography of past societies is evaluated. The fusion of the various epiphyses occurs at a specified order and period of time in life and their correlation is useful to establish an age in both antemortem & post-mortem cases. By taking into account the radiological analysis of epiphyseal union

at iliac crest & ischial tuberosity, this study will be of immense help in further understanding the details of accurate assessment of age in Central Indian population.

Aims and Objectives:

1. To evaluate age specific difference in epiphyseal union at iliac crest & ischial tuberosity.
2. To estimate age from epiphyseal union at iliac crest & ischial tuberosity.
3. To compare bisexual difference in epiphyseal union at iliac crest & ischial tuberosity.
4. To compare the findings of epiphyseal union at iliac crest & ischial tuberosity in Central Indian population with other parts of India.

Material and Method

The present study was carried out in the Department of Forensic Medicinein collaboration with Department of Radiology, SSIMS, Bhilai, Chhattisgarh. A total of 140 individuals participated in this study. The subjects included were individuals of 17-24 years of age from Bhilai & Durgcity. They are born to parents domicile

Corresponding Author:

Dr. Swapnil Patond

Associate Professor, Department of Forensic Medicine, Jawaharlal Nehru Medical College, DMIMS, Wardha

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 the subjects prior to each procedure. Skeletal maturity was evaluated according to the Jit & Kulkarni's classification¹ 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)	Iliac crest			Ischial tuberosity		
	NF	PF	CF	NF	PF	CF
17-18	4	6	0	7	3	0
18-19	2	8	0	3	7	0
19-20	0	10	0	0	10	0
20-21	0	2	8	0	7	3
21-22	0	0	10	0	0	10
22-23	0	0	10	0	0	10
23-24	0	0	10	0	0	10
Total	70 (100%)			70 (100%)		

Table 2: Epiphyseal fusion in females:

Age (years)	Iliac crest			Ischial tuberosity		
	NF	PF	CF	NF	PF	CF
17-18	2	8	0	6	4	0
18-19	0	10	0	0	10	0
19-20	0	5	5	0	8	2
20-21	0	2	8	0	6	4
21-22	0	0	10	0	0	10
22-23	0	0	10	0	0	10
23-24	0	0	10	0	0	10
Total	70 (100%)			70 (100%)		

In males, iliac crest shows: non fusion in 6 (8.57%) cases in age group of 17-19 years, partial fusion in 26(37.14%) cases in age group of 17-21 years & complete fusion in 38 (54.28%) cases in age group of 20-24 years. Complete fusion is seen in all the subjects in age group of 21-24 years. In females, iliac crest shows: non fusion in 2 (52.85%) cases in age group of 17-18 years, partial fusion in 25 (35.71%) cases in age group of 17-21 years & complete fusion in 43 (61.42%) cases in age group of

19-24 years. Complete fusion is seen in all the subjects in age group of 21-24 years.

In males, ischial tuberosity shows: non fusion in 10 (14.28%) cases in age group of 17-19 years, partial fusion in 27 (38.57%) cases in age group of 17-21 years & complete fusion in 33 (47.14%) cases in age group of 20-24 years. Complete fusion is seen in all the subjects in age group of 21-24 years. In females, ischial tuberosity

shows: non fusion in 6 (8.57%) cases in age group of 17-18 years, partial fusion in 28 (40%) cases in age group of 17-21 years & complete fusion in 36 (51.42%) cases in age group of 19-24 years. Complete fusion is seen in all the subjects in age group of 21-24 years.

Discussion

Table 3: Comparison of Age of union (years)

Sr. No	Researcher	Region/population	Iliac crest		Ischial tuberosity	
			Male	Female	Male	Female
1	Galstaun ²	Bengalis	19-20	17-9	20	20
2	Pillai ³	Madrasis	14-18	14-18	-	-
3	Flecker ⁴	Australia	18	15-16	20	-
4	Davies & Parson ⁵	English	23	23	-	-
5	Dasgupta et al ⁶	Uttar Pradesh	19-20	19-20	-	-
6	Parikh ⁷	Indian	20-21	18-19	23-24	21-22
7	SankhynS et al ⁸	Himachal Pradesh	21 ^{1/2}	21 ^{1/2}	-	-
8	Bennet KA ⁹	USA	23	23	24-25	24-25
9	BhiseS et al ¹⁰	Mumbai	21-22	20-21	21-22	21-22
10	Devraj N et al ¹¹	Maharashtra	-	20-21	-	20-21
11	Sangma W et al ¹²	Manipur	-	21	-	21
12	Sharma Y et al ¹³	Rajasthan	21-22	20-21	21-22	21-22
13	Singh P et al ¹⁴	Punjab	-	-	20-21	20-21
14	Naik M et al ¹⁵	Andhra Pradesh	15-17	15-17	17-18	17-18
15	Present study	Chhattisgarh	21-22	21-22	21-22	21-22

Iliac Crest: The observations of present study for males, matches with work of Parikh⁷, SankhynS et al⁸, BhiseS et al¹⁰ & Sharma Y et al¹³. For females, the observations match with the findings of SankhynS et al⁸, Bhise S et al¹⁰, Devraj N et al¹¹ & Sharma Y et al¹³.

Ischial Tuberosity: The observations of present study for males, matches with work of BhiseS et al¹⁰, Sharma Y et al¹³ & Singh P et al¹⁴. For females, the observations match with the findings of Parikh⁷, Bhise S et al¹⁰, Devraj N et al¹¹, Sangma W et al¹², Sharma Y et al¹³ & Singh P et al¹⁴.

Summary and Conclusion:

1. This study was conducted exclusively on the young indigenous population of Central India.
2. The epiphyseal union at iliac crest in both males & females is completed in all instances (100%) at the age of 21-22 years.

3. The epiphyseal union at ischial tuberosity in both males & females is completed in all instances (100%) at the age of 21-22 years.
4. Central Indian inhabitants are of diverse type comprising of various castes, religions & tribes. The opinion about age should always be given in the range.
5. From this study, range of 1-2 years of margin of error can be concluded.
6. For age estimation, pertinent 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.

References

1. Jit I, Kulkarni M. Time of appearance and fusion of epiphysis at medial end of clavicle. *Indian J Med Res* .1976 May; 64(5):773-82.
2. Galstaun, G. *Indian Journal of Medical Research* (1937) 25,267.
3. Pillai M. The study of epiphysial union for determining the age of south Indians. *Indian J Med Res* 1936; 23:1015-1017.
4. Flecker H. Time of appearance and fusion of ossification centers. *Am J Roentgenol* 1942; 47: 97-159.
5. Davies D & Parsons F. The age order of the appearance and union of the normal epiphyses as seen by X-rays. *J Anat.* 1927 Oct; 62(Pt 1): 58–71.
6. Dasgupta SM et al. A Roentgenographic study of epiphysial union around elbow, wrist, knee, and pelvic joints in boys and girls of U.P. *Journal of Medical Association* 1974; 62(1):10-12.
7. Parikh. Personal identity, Parikh's Textbook of Medical Jurisprudence and Toxicology. C.B.S. (ed.) 5th; 1990, 39 – 50.
8. Sankhyan S et al. Age and ossification of some hip bonecentres in Himachal pradesh *JFMT*, X, 3-5, 1993.
9. Bennet KA. Metric and nonmetric data for estimation of age. A field guide for human skeletal identification. Charles Thomas USA, 2ndedn, 59-65, 1993.
10. Bhise S et al. Age Determination from Pelvis: A Radiological Study in Mumbai Region. *J Indian Acad Forensic Med.* 2012; 34(2): 104-107.
11. Devraj N et al. Age Determination of Prostitute Women by Radiological Investigation. *Indian Journal of Forensic Medicine & Toxicology.* 2019; 13(1): 40-45.
12. Sangma W et al. Age Determination in Girls of North – Eastern Region of India. *JIAFM.* 2007; 29(4): 102-108.
13. Sharma Y et al. Union of Epiphyseal Centres in Pelvis of Age Group 18-21 Years in Rajasthan: A Roentgenologic Prospective Study. *J Indian Acad Forensic Med.* 2013; 35(2): 134-136.
14. Singh P et al. Age Estimation from Epiphyseal Fusion of Ischial Tuberosity. *J Indian Acad Forensic Med.* 2013; 35(3): 197-199.
15. Naik M, Master B. Age Estimation among 12-18 Years Children by the Ossification Centers of Hip Joint and Pelvis. *Ann. Int. Med. Den. Res.* 2017; 3(3):FM01-FM03.