

Radiological Study of Ossification Centres Around Pelvis to Determine Their Age of Appearance and Fusion among Bengali Population – A Retrospective Study

Deepsekhar Dalal¹, Abhishek Das¹, Sujash Biswas²

¹Assistant Professor, Department of Forensic and State Medicine, Medical College, Kolkata, ²Associate Professor, Department of Forensic Medicine and Toxicology, Rampurhat Government Medical College, West Bengal

Abstract

Introduction and background: Radiological data of appearance and fusion of ossification centres are mostly used to determine age of individuals and compare with chronological age for medicolegal purposes. X-Ray of pelvis is very important for elderly adolescent age group. Objectives: This study has been conducted to study the age of appearance and fusion of ossification centres around pelvis for known chronological aged subjects from Bengali population and compare them with known standards. Methods: In this retrospective study x-ray films of 74 females and 220 males of 8 to 21 years age group from the period of 1st January 2017 to 31st December 2019 have been observed. Data analyzed in Microsoft office excel 10 and presented in the form of table and diagram. Conclusion: The study reveals age of appearance and fusion of ossification centres around pelvis in Bengali population which corroborate with standard values in some cases and in some do not match. It will help to estimate age of individuals for medicolegal purpose.

Key words – Radiological, medicolegal, adolescent, pelvis, tri-radiate cartilage, iliac crest

Introduction

Estimation of age is relevant from both civil and criminal point of view in medicolegal practice. Identification of an individual, establishing criminal responsibility, juvenile crime, participation in sports are some major fields where age estimation is required to be done. For this purpose we have to depend mostly on dental and radiological data. The appearance of ossification centres is completed around 5 years and after this fusion acts as calendar upto the age of 25^[15]. Where X- ray of wrist and elbow helps to determine age in children and early adolescents, x-ray of pelvis is mostly done for older adolescents. For this purpose still we are dependent upon age old data. Moreover as we know that skeletal development is influenced by nutritional status, environmental condition and other factors, studies on

different geographical area are necessary in present scenario. The present study has been carried out among 220 males and 74 females of Bengali subjects between the age group of 8 to 21 years. Our objectives are to observe status of appearance and fusion of ossification centres around pelvis for a known chronological age, to determine range of their appearance and fusion in males and females and to compare them with known standards.

Materials and Methods

It was a cross sectional study. The study was carried out in Dept. of FSM, Medical College Kolkata over a period of six months. State of appearance and fusion of ossification centres of iliac crest, ischial tuberosity, head of femur, greater trochanter, lesser trochanter and tri-radiate cartilage were examined. X-Ray plates of all 220 males and 74 females who attended the department for age estimation between 1st January 2017 and 31st December 2019 were studied in a Census sampling except those cases who have fallen under exclusion criteria. Stated age of the subjects were confirmed from age proof documents. Epiphysis of said bony structures

Corresponding author:

Dr. Sujash Biswas

Mobile- 8017650885

E-mail: drsujashnrs@gmail.com

were examined to observe

1. Whether appeared
2. Whether fusion started
3. Whether fusion is in process
4. Whether fusion completed

Epiphyseal scar at the junction of epiphysis and metaphysis has been considered as indicator of complete fusion^[14].

Results and Observation

220 males (8 to 21 years) and 74 females (8 to 16 years) were divided into 13 and 9 groups respectively with 1 year interval between each group. Number of male and female subjects in different age groups is respectively as follows:

8 yrs – 3 and 6 (total 9), 9 yrs – 22 and 10 (total 32), 10 years – 20 and 9 (total 29), 11 years – 18 and 11 (total 29), 12 years – 36 and 21 (total 57), 13 years – 29 and 6 (total 35), 14 years – 29 and 5 (total 34), 15 years – 20 and 2 (total 22), 16 years – 21 and 4 (total 25), 17 years – 18 and 0 (total 18), 18 years – 1 and 0 (total 1), 19 years – 1 and 0 (total 1), 21 years – 2 and 0 (total 2)

Appearance of iliac crest:

Among females, radiological evidence of appearance have been detected between 11 to 16 years of age. Iliac crest appeared in 36.49% of total sample. 100% subjects showed evidence of appearance at the age of 13, 15 and 16. In males, 43.18% showed evidence of appearance at and beyond 12 years of age. 100% subjects showed evidence of appearance at the age of 15 years and above. **(Table 1)**

Fusion of Iliac crest:

Among females, none showed evidence of complete fusion. Fusion did not start in any subject before 12 years. Fusion started among 100% subjects at 15 and 16 years of age whereas process of fusion has been noticed between 12 to 14 years. Among males, fusion completed in only 2.27% subject (at the age of 19 and 21). Fusion did not start upto 11 years of age whereas evidence of fusion process has been noticed between 12 to 18 years of age. **(Table 1)**

Appearance of Ischial tuberosity:

It did not show radiological evidence of appearance upto 11 years of age in both genders. In 100% cases it appeared at 15 and 16 years of age in females and at 18, 19 and 21 years of age in males. **(Table 2)**

Fusion of Ischial tuberosity:

No evidence of complete fusion in females and 2.25% of complete fusion in males among whom the data was 100% at the age of 21. Fusion did not start upto 11 years of age in females and 12 years of age in males. In females, process of fusion has been noticed between 12 to 16 years of age and in males its 13 to 19 years.. **(Table 2)**

Disappearance of tri-radiate cartilage:

In females, upto the age of 10 years, tri-radiate cartilage was present in all cases. It was disappeared in 100% cases at the age of 14, 15 and 16. Among males, it was detected upto 11 years of age in 100% subjects whereas disappeared in 100% cases at the age of 17, 19 and 21 **(Table 3)**

Appearance of head of radius:

It appeared in all subjects earliest at the age of 8 years. **(Table 4)**

Fusion of head of femur:

Fusion started in all subjects except one 10 yrs old female. Complete fusion took place in 35.14% of female population (100% at the age of 15 and 16 years). Process of fusion noticed between 8 to 14 years age. In males, fusion was complete in 100% subject of 18, 19 and 21 years of age whereas process of fusion has been detected in 61.36% males between the ages of 8 to 17. **(Table 4)**

Appearance of Greater Trochanter:

All subjects have shown evidence of appearance of greater trochanter. **(Table 5)**

Fusion of Greater Trochanter:

In females fusion did not start in only one and completed in 18.92% individuals between the age group of 12 to 16. Process of fusion has been noticed between 8 to 15 years of age group. Among males 24.55% of

sample showed evidence of complete fusion between the age of 13 to 21 and it was 100% at 18, 19 and 21 years age. Process of fusion has been observed in 150 males between the age of 8 to 17. (Table 5)

Appearance of lesser trochanter:

Evidence of appearance has been observed in 78.38% females (mostly 12 to 16 years) and 77.27% males (mostly 14 to 21 years) (Table 6)

Fusion of lesser trochanter:

In females 100% showed complete fusion at 15 and 16 years of age. 47.30% males showed process of fusion between 8 to 14 years. Among males, complete fusion was detected in 100% population at 18, 19 and 21 years of age. Process of fusion was detected in 42.73% subjects between 8 to 17 years age. (Table 6)

Table 1: Age (in years) of appearance and fusion of Iliac Crest (n = 294)

Age (yrs)	Not appeared		Appeared		Fusion not started		Fusion in process		Fusion completed	
	F	M	F	M	F	M	F	M	F	M
8	6	4			6	3				
9	10	22			10	22				
10	9	20			9	20				
11	9	18	2		11	18				
12	11	31	10	5	17	33	4	3		
13		20	6	9	5	27	1	2		
14	2	9	3	20	2	24	3	5		
15		1	2	19		10	2	10		
16			4	21		8	4	13		
17		1		17		3		13		2
18				1				1		
19				1						1
21				2						2

Table 2: Age (in years) of appearance and fusion of Ischial Tuberosity (n = 294)

Age (yrs)	Not appeared		Appeared		Fusion not started		Fusion in process		Fusion completed	
	F	M	F	M	F	M	F	M	F	M
8	6	3			6	3				
9	10	22			10	22				
10	9	20			9	20				
11	11	18			11	18				
12	15	34	6	2	19	36	2			
13	4	27	2	2	6	27	3	2		
14	2	17	3	12	2	25		4		
15		8	2	12	1	14	1	6		
16		4	4	17		9	4	11		1
17		3		15		4		13		1
18				1				1		
19				1				1		
21				2						2

Table 3: Age (in years) of disappearance of tri-radiate Cartilage (n = 294)

Age (yrs)	Present		Absent	
	F	M	F	M
8	6	3		
9	10	22		
10	9	20		
11	8	18	3	
12	10	33	11	3
13	2	22	4	7
14		12	5	17
15		2	2	18
16		1	4	20
17				18
18		1		
19				1
21				2

Table 4: Age (in years) of appearance and fusion of Head of Femur (n = 294)

Age (yrs)	Not appeared		Appeared		Fusion not started		Fusion in process		Fusion completed	
	F	M	F	M	F	M	F	M	F	M
8			6	3			6	3		
9			10	22		3	10	19		
10			9	20	1	3	7	17	1	
11			11	18		3	8	13	3	2
12			21	36		1	12	34	9	1
13			6	29		2	3	24	3	3
14			5	29			1	15	4	14
15			2	20				6	2	14
16			4	21				3	4	18
17				18				1		17
18				1						1
19				1						1
21				2						2

Table 5: Age (in years) of appearance and fusion of Greater Trochanter (n = 294)

Age (yrs)	Not appeared		Appeared		Fusion not started		Fusion in process		Fusion completed	
	F	M	F	M	F	M	F	M	F	M
8			6	3			6	3		
9			10	22		2	10	20		
10			9	20	1	5	8	15		
11			11	18		3	11	15		
12			21	36		4	18	32	3	
13			6	29		2	4	26	2	1
14			5	29			1	22	4	7
15			2	20			1	10	1	10
16			4	21				3	4	18
17				18				4		14
18				1						1
19				1						1
21				2						2

Table 6: Age (in years) of appearance and fusion of Lesser Trochanter (n = 294)

Age (yrs)	Not appeared		Appeared		Fusion not started		Fusion in process		Fusion completed	
	F	M	F	M	F	M	F	M	F	M
8	4	2	2	1	4	2	2	1		
9	8	18	2	4	8	19	2	3		
10	3	16	6	4	4	19	5	1		
11	1	10	10	8	5	14	6	4		
12		3	21	33	1	4	14	32	6	
13		1	6	28		6	4	21	2	2
14			5	29			2	18	3	11
15			2	20				9	2	11
16			4	21				3	4	18
17				18				2		16
18				1						1
19				1						1
21				2						2

Discussion

Age old Galstaun chart is followed till now for estimation of skeletal age. In this study we tried to produce a standard reference range of age for appearance and fusion of ossification centres around pelvis so that it can help to corroborate skeletal age and chronological age of Bengali population in present scenario. Such studies among males and females have been conducted in many parts of India but it's not a common one among Bengali population in recent years.

As of conventional data, in our study ossification centres appeared early in females compared to males^[15]. Though earliest age of appearance of Ischial Tuberosity is same (12 years) in males and females according to present study 100% appearance occurred earlier in females. Similarly fusion also completed earlier in females except Ischial Tuberosity.

In our study appearance of iliac crest started by 11 years in females and 12 years in males and completed by 15 years and 17 to 18 years in females and males respectively. Starting age of appearance corroborates with finding of Srinivasa Naik M et al^[10] but completion age is less. Findings of our study also nearly matched with finding of Bhise S.S. et al^[2]. We could not draw any conclusion regarding fusion of iliac crest in females, in males it completed by 19 to 21 years which corresponds with result of Patel G et al^[9].

Considering Ischial Tuberosity, appearance completed by 15 to 16 years in females and 18 to 19 years in males. It corresponds with findings of Srinivasa Naik M et al^[10] for females and corroborates with finding of Bhise S.S et al^[2] for males. Here also we could not draw any conclusion for age of fusion for females but in males, fusion completes by 21 years which is less than the finding of Sing P et al^[3] but corroborates nearly with study of Joshi A et al^[4].

As per present study, tri-radiate cartilage completely disappeared by 14 years in females and 17 years in males which corroborates with finding of Shilajiya et al^[8] and Galstaun G^[13] for females. It does not correspond with the findings of Bangal RS et al^[5].

Fusion of head of femur completes by 15 years in females and 18 years in males. The value corroborates with Galstaun G^[13] for females. Value corresponds with

findings of Srinivasa Naik M et al^[13] and Sharma Y et al^[1].

Greater trochanter fused by the age of 16 in females and 18 in males. Value does not corroborate with findings of Galstaun G^[13]. Value corroborates with finding of Sharma Y et al^[1].

In present study lesser trochanter fuses by 15 years in females which corroborates with Galstaun G but its 18 years for males which does not corroborates with Sharma Y et al^[1] but corroborates with Srinivasa Naik M et al^[10].

Conclusion

Such a study among both males and females on this large sample size was required in West Bengal. By this study we reached a conclusion about age of appearance of ossification centres around pelvis which vary in many cases from age old data which is considered till date. The data recommended by us can be taken as reference in future for the purpose of age estimation among elderly adolescent group.

Conflict of Interest: Nil

Ethical Clearance: Obtained from Institutional Ethics Committee, Medical College Kolkata

Source of Funding: Not applicable

Contribution of Authors: We declare that this work was done by the authors named in this article and all liabilities about claims relating to the content of this article will be borne by the authors.

References

1. Sharma Y, Sharma A, Bohra B. Union of Epiphyseal Centres in Pelvis of age group 18-21 years in Rajasthan – A Roentgenologic Prospective Study. *Journal of Indian Academy of Forensic Medicine*. 2013; 35(2): 134-136
2. Bhise S,S, Nanandkar S.D. Age determination from Pelvis A Radiological Study in Mumbai Region. *Journal of Indian Academy of Forensic Medicine*. 2012; 34(2): 104-107
3. Singh P, Pal Singh V, Gorea R.K, Kapalia A.K. Age estimation from Epiphyseal fusion of Ischial Tuberosity. *Journal of Indian Academy of Forensic*

- Medicine. 2013; 35(3): 197 – 199
4. Joshi A, Garg R, Gupta A, Garg A. Age determination by development of 3rd molar teeth with Rongengraphic skeletal relationship of iliac crest and ischial tuberosity in Bikaner city. *Journal of Indian Academy of Forensic Medicine*. 2015; 37(3): 286-288
 5. Bangal RS, Bhise SS, Nanandkar SD. Age determination from Triradiate cartilage fusion – A Radiological study in Mumbai region. *Journal of Indian Academy of Forensic Medicine*. 2016; 38(3): 271-273
 6. Li Y, Haung Z, Dong X, Liang W, Xue H, Zhang L, Zhang Y, Deng Z. Forensic age estimation for pelvic x-ray images using deep learning. *European Radiology*. Nov 2018: 5791-6
 7. Sudha R. Age estimation of rescued female commercial sex workers and male child labourers in South India. *Int Journal of Health Research and Medicolegal Practice*. 2011; 4(1): 86-89
 8. Shilajiya D, Patel D, Shah K, Govekar G, Patel G. Radiological study of disappearance of tri-radiate cartilage in pelvic bone in Gujrat population. *Journal of Indian Academy of Forensic Medicine*. 2011; 32(3): 232-236
 9. Patel G, Shilajiya D, Govekar G, Tailor C. Radiological study of fusion of iliac crest by digital method. *Journal of Indian Academy of Forensic Medicine*. 2011; 33(4): 301-305
 10. Srinivasa Naik M, Brahmaji Master P. Age estimation among 12-18 years children by the by the ossification centres of hip joint and pelvis. *Annals of International Medical and Dental Research*. 2017; 3(3): 1-3
 11. Alok Kumar et al. Estimation of age from pelvis – a radiological study. *Indian Internet Journal of Forensic Medicine and Toxicology*. 2004; 1(3)
 12. Saukko P, Knight B. *Knight Forensic Pathology*. CRC Press; 4th Ed: 112-115
 13. Galstaun G. A study of ossification as observed in Indian subject. *Indian J Med Res*. 1937; 25(1): 267-324
 14. Aggrawal A. *Forensic Medicine and Toxicology*. APC publisher; 1st Ed: 81.
 15. Reddy K.S.N. *The Essentials of Forensic Medicine and Toxicology*. Jaypee publishers; 34th Ed: 70