Original Article

Age Estimation among 12-18 Years Children by Studying the Ossification Centers of Hip Joint and Pelvis

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Abstract

Background: Bone age is an indicator of the skeletal and biological maturity of an individual. Skeletal ossification progression studies are one of them and are admissible in court as unparalleled scientific evidence for age estimation. Age group of juveniles between 12 - 18 years is dealt with special laws for medico- legal cases.

Aims & Objective: To observe age of appearance and fusion of ossification centers of hip joint and pelvic bone in adolescent population of Jaipur.

Material & Methodology: An observational prospective study that used inclusion and exclusion criteria was conducted. Healthy Adolescents of 12-18 years of age group from Jaipur were taken in the study. The present study had been conducted in the Department of Forensic Medicine & Toxicology, SMS Hospital, Jaipur with Department of Radiology, SMS Medical College and Attached Hospitals, Jaipur during the period from June 2021 to May 2022.

Result & Observation: Appearance of triradiate cartilage was found earliest at the age of 12 – 13 years in both sexes, complete fusion was found earliest at the age 13 - 14 years in females and 14 – 15 years in males. Appearance of ossification centre of Ischial Tuberosity was found earliest at the age of 12 – 13 years in males and females; old fusion is earliest found at the age of 17 - 18 years in females and was not found in males. Appearance of ossification centre of Iliac Crest was found earliest at the age of 12 – 13 years in males and females; old fusion is earliest found at the age of 17 - 18 years in both male & females. Appearance of ossification centre of Pubis was found earliest at the age of 12 – 13 years in males and females; old fusion is earliest found at the age of 17 - 18 years in females and was not found in males.

Conclusion: Appearance and fusion of ossification centers for hip joint & pelvis joint can be implemented in routine forensic practice for 12 – 18 years age group to opine about age of subjects with lesser age range.

Key word: Age estimation, Hip Joint, X-ray, Pelvis, Ossification.

Introduction

Bone age is an indicator of the skeletal and biological maturity of an individual[1]. Various radiological methods have been developed for skeletal age estimation, one of the simplest, oldest and most commonly used method of bone age calculation is the study of ossification centers[2].

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Skeletal ossification progression studies are one of them and are admissible in court as unparalleled scientific evidence for age estimation[3]. Age group of juveniles between 12 - 18 years is dealt with special laws for medico- legal cases. For forensic experts in India, age estimation is a challenging task as criminal responsibility of these juveniles depends on it[4] ; as In India, most of the children especially those residing in rural areas are facing much problems related to dietary habits, social customs, etc and diet deficient in essential components like vitamins and minerals influence the growth of bones[5]. Timing of epiphyseal union is an important means to estimate the age of adolescent and young adult skeletons[6]. There is scarcity of available literature for age of appearance and fusion of ossification centres of hip joint and pelvis in natives of Jaipur, hence this study is being undertaken to analysis age of fusion at hip joint and pelvis adolescent population of Jaipur.

Aim and objectives

Study was conducted to determine age of appearance and complete fusion of Tri-radiate cartilage, Ischial tuberosity, Iliac crest and Pubis among adolescent age group.

Materials and Method

A prospective analytical study was done from June 2021 to May 2022 for age determination by estimating the ossification centers of hip joint. The study was undertaken after taking institutional ethical committee approval at Department of Forensic, SMS Medical College and Attached Group of Hospitals, Jaipur in collaboration with Department of Radiology, SMS Medical College and Attached Hospitals, Jaipur. 10 subjects each of both genders were included for yearly interval for adolescent age group (12-13,13- 14,14-15,15-16,16-17,17-18) i.e. 20 in each group (10 males and 10 females); and 120 subjects were included in the study who gave written informed consent for participation in the study were included in this study. We excluded Subjects with Chronic illness, Endocrinal disorders, Severe malnutrition- weight/age <60%, Radiographs that displayed major anomalies or Previous skeletal trauma (e.g., fractures) of the bones and Chronic drug intake affecting development like e.g.-antiepileptic drug, steroid.Plain radiographs of Pelvis and Hip joints were done for each subject in the Department of Radiology on Digital X-ray machine and the X-ray film was obtained for observation of appearance and completed fusion of the various ossification centers of the Pelvis and Hip joint. All Radiographs were done on same machine using the same technique and the X-rays were observed by the same set of observers i.e., the investigator under supervision of the co-guide from the Department of Radiology.

The staging was done according to staging given by **Sankhyan,** 1993[7]

Stage 1: Ossification Center Not Appeared. Stage 2: Ossification Center Appeared. Stage 3: Partial fusion.

Stage 4: Recent Fusion

Stage 5: Old Fusion.

All data was gathered and stored in Microsoft Excel data sheet and further tabulated, charted and analysed.

Observations and Results

In present study we had taken 10 male & 10 female in each six group, A(12-13 years), B(13-14 years), C(14-15 years), D(15-16 years), E(16-17 years), F(17-18 years).

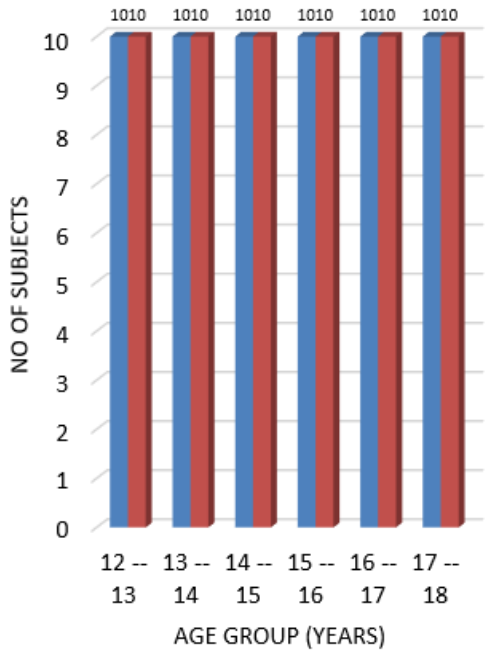

Figure 1: Showing Age Group & Gender Wise Distribution Of Subject

Table 1: Staging of Ossification Center in Age group 12 – 13 years.

12 – 13 Years		I	II	III	IV	V
Triradiate Cartilage	M	00	04	03	03	00
	F	00	00	05	05	00
Ischial Tuberosity	M	09	01	00	00	00
	F	06	04	00	00	00
Iliac Crest	M	09	01	00	00	00
	F	06	04	00	00	00
Pubis	M	08	02	00	00	00
	F	04	06	00	00	00

Table 2: Staging of Ossification Center in Age group 13 – 14 years.

13 – 14 Years		I	II	III	IV	V
Triradiate Cartilage	M	00	03	03	02	02
	F	00	00	01	09	00
Ischial Tuberosity	M	09	01	00	00	00
	F	05	05	00	00	00
Iliac Crest	M	08	02	00	00	00
	F	02	08	00	00	00
Pubis	M	07	03	00	00	00
	F	04	06	00	00	00

Table 3: Staging of Ossification Center in Age group 14 – 15 years.

14 – 15 Years		I	II	III	IV	V
Triradiate Cartilage	M	00	01	04	03	02
	F	00	00	03	04	03
Ischial Tuberosity	M	06	04	00	00	00
	F	03	07	00	00	00
Iliac Crest	M	05	05	00	00	00
	F	01	09	00	00	00
Pubis	M	02	08	00	00	00
	F	01	09	00	00	00

Table 4: Staging of Ossification Center in Age group 15 – 16 years.

15 – 16 Years		I	II	III	IV	V
Triradiate Cartilage	M	00	00	03	03	04
	F	00	00	00	04	06
Ischial Tuberosity	M	03	07	00	00	00
	F	00	08	02	00	00
Iliac Crest	M	02	08	00	00	00
	F	00	08	02	00	00
Pubis	M	00	09	01	00	00
	F	00	08	02	00	00

Table 5: Staging of Ossification Center in Age group 16 – 17 years.

16 – 17 Years		I	II	III	IV	V
Triradiate Cartilage	M	00	00	00	02	08
	F	00	00	00	01	09
Ischial Tuberosity	M	00	09	01	00	00
	F	00	06	04	00	00
Iliac Crest	M	00	09	01	00	00
	F	00	07	03	00	00
Pubis	M	00	07	03	00	00
	F	00	05	04	01	00

Table 6: Staging of Ossification Center in Age group 17 – 18 years.

17 – 18 Years		I	II	III	IV	V
Triradiate Cartilage	M	00	00	00	00	10
	F	00	00	00	00	10
Ischial Tuberosity	M	00	05	03	02	00
	F	00	01	06	02	01
Iliac Crest	M	00	01	07	01	01
	F	00	01	04	04	01
Pubis	M	00	05	03	02	00
	F	00	01	05	02	02

Appearance of triradiate cartilage was found earliest at the age of 12 – 13 years in both sexes, complete fusion was found earliest at the age 13 - 14 years in females and 14 – 15 years in males.

Appearance of ossification centre of Ischial Tuberosity was found earliest at the age of 12 – 13 years in males and females; old fusion is earliest found at the age of 17 - 18 years in females and was not found in males.

Appearance of ossification centre of Iliac Crest was found earliest at the age of 12 – 13 years in males and females; old fusion is earliest found at the age of 17 - 18 years in both male & females.

Appearance of ossification centre of Pubis was found earliest at the age of 12 – 13 years in males and females; old fusion is earliest found at the age of 17 - 18 years in females and was not found in males.

Discussion

Table 7: Appearance and Fusion of the Ossification Centre of Tri-Radiate Cartilage:

	Tri-radiate Cartilage			
	Appears		Fusion	
	Male	Female	Male	Female
N. Reddy[46]	13		14	
Bhaisoria & Chaudhary[47]	10-13	12-13	14-15	14
Apurba Nandy[48]	10-14	12-14	14-16	15
Bardale Rajesh[49]	-	-	15-16	13-14
Krishnan MKR[50]	-	-	14-15	13-14
Yatiraj S[29]	-	-	16-17	15-16
Mathur I[42]	12-13	12-13	15-16	15-16
Srinivas NM[38]	-	-	15-16	14-15
Present study	12-13	12-13	15-16	15-16

In present study Ossification of triradiate cartilage appears at the age of 12 – 13 years in majority of subjects in both male & female which is comparable to the study of **N. Reddy; Bhaisoria & Chaudhary**; **Apurba Nandy** and **Mathur I,** however there is no comment about appearance of ossification center in study of **Bardale Rajesh**; **Krishnan MKR; Yatiraj S** and **Srinivas NM.**

In present study Ossification of triradiate cartilage complted by the age of 15 – 16 years in majority of male subjects & female subjects which is comparable to the study of **Apurba Nandy; Bardale Rajesh; Mathur I** and **Srinivas NM** in males and **ApurbaNandy**; **Yatiraj S** and **Mathur I** in females. However there is early fusion in males present in study of **N. Reddy; Bhaisoria & Chaudhary** and **Krishnan MKR** and early fusion in females present in study of **N. Reddy; Bhaisoria & Chaudhary; Bardale Rajesh**; **Krishnan MKR** and **Srinivas NM** and there is delayed fusion in males in study of **Yatiraj S.**

Table 8: Appearance and Fusion of the Ossification Centre of Iliac Crest:

	Iliac Crest			
	Appears		Fusion	
	Male	Female	Male	Female
N. Reddy[46]	14		20-21	
Bhaisoria & Chaudhary[47]	17	14	19-20	17-19
Apurba Nandy[48]	16	15	19-20	17-19
Bardale Rajesh[49]	17	14	19-20	17-19
Krishnan MKR[50]	15-17	14-16	19-20	18-19
Yatiraj S[29]	-	-	16-17	15-16
Mathur I[42]	15-16	15-16	20-21	19-20
Srinivas NM[38]	-	-	16-17	15-16
Present study	15-16	13-14	>17-18	>17-18

In present study Ossification of Iliac Crest appears at the age of 15 – 16 years in majority of subjects in male subjects & 13 – 14 years in majority of female subjects which is comparable to the study of **Apurba Nandy; Krishnan MKR** and **Mathur I** in males and study of **N. Reddy; Bhaisoria & Chaudhary**; **Bardale Rajesh**; **Krishna MKR** in females, there is delayed appearance in study of **Bhaisoria & Chaudhary** & **Bardale Rajesh** in males and in study of **Apurba Nandy** and **Mathur I** in Females, early appearance present in study of **N. Reddy** in males.

In present study Ossification of Iliac Crest does not completed by the age of 17 – 18 years in majority of male & female subjects which is comparable to the study of **N. Reddy; Bhaisoria & Chaudhary; Apurba Nandy; Bardale Rajesh; ApurbaNandy; Krishnan MKR** and **Mathur I,** however there is early fusion is present in both male and female subjects in study of **Yatiraj S** and **Srinivas NM.**

Table 9: Appearance and Fusion of the Ossification Centre of Ischial Tuberosity:

	Ischial Tuberosity			
	Appears		Fusion	
	Male	Female	Male	Female
N. Reddy[8]	16		20-21	
Bhaisoria& Chaudhary[9]	16-18	14-16	20	20
Apurba Nandy[10]	15-17	14-15	20	20
Bardale Rajesh[11]	16-18	14-16	20	20
Krishnan MKR[12]	16-18	15-17	20-21	19-20
Yatiraj S[13]	—	—	16-17	15-16
Mathur I[14]	18-19	17-18	20-21	20-21
Srinivas NM[15]	—	—	15-16	15-16
Present study	15-16	13-14	>17-18	>17-18

In present study Ossification of Ischial Tuberosity appears at the age of 15 – 16 years in majority of male subjects & 14 – 15 years in majority of female subjects which is comparable to the study of **Apurba Nandy** & **N. Reddy** in males and study of **Apurba Nandy** in females, there is delayed appearance in study of **Bhaisoria & Chaudhary; Bardale Rajesh; Krishnan MKR** and **Mathur I** in males and in study of **N. Reddy; Bhaisoria & Chaudhary**; **Bardale Rajesh;Krishnan MKR** and **Mathur I** in females**.**

In present study Ossification of Ischial tuberosity does not completed by the age of 17 – 18 years in majority of male & female subjects which is comparable to the study of **N. Reddy; Bhaisoria & Chaudhary; Bardale Rajesh; Apurba Nandy; Krishnan MKR** and **Mathur I,** however there is early fusion present in the study of **Yatiraj S** and **Srinivas NM.**

Table 10: Appearance and Fusion of the Ossification Centre of Pubis:

	Pubis			
	Appears		Fusion	
	Male	Female	Male	Female
Yatiraj S[13]	—	—	15-16	15-16
Srinivas NM[15]	—	—	16-17	15-16
Present study	15-16	14-15	>17-18	>17-18

In present study Ossification of Pubis appears at the age of 15 – 16 years in majority of male subjects & 14 – 15 years in majority of female subjects, however there were no comment on this section in the studies that we have taken for comparison.

In present study Ossification of Pubis does not completed by the age of 17 – 18 years in majority of male & female subjects, however there is early fusion present in both male & female subjects in study of **Yatiraj S** and **Srinivas NM.**

Conclusion

The present study concludes that the study of appearance and fusion of ossification centers for hip joint & pelvis joint can be implemented in routine forensic practice for 12 – 18 years age group to opine about age of subjects with lesser age range.

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Ethical approval: From the institutional ethical committee.

Conflict of interest: Nil

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