e-ISSN: 0975-1556, p-ISSN:2820-2643

Available online on www.ijpcr.com

International Journal of Pharmaceutical and Clinical Research 2023; 15(5); 869-875

Original Research Article

Radiological Study of Secondary Ossification Centers around the Elbow Joint in North Bihar

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Received: 13-03-2023 / Revised: 19-04-2023 / Accepted: 02-05-2023

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Conflict of interest: Nil

Abstract

Background: The bones of human skeletons develop from separate Ossification centers. From these centers ossification progresses till the bone is completely formed. These Changes can be studied by means of x-rays. It is therefore possible to determine the approximate age of an individual by radiological examination of bones till ossification is complete.

Materials & Methods: This radiological study was carried out with the objective to assess the skeletal maturity round elbow joint, of subjects in North Bihar region, 168 Males and 132 Females between age group of 10-19 years and size of dwelling in North Bihar more than 10 years. Subjects representing the heterogenous population of Bihar were included from first year MBBS students of Katihar Medical College, Katihar of different districts of this state, schools as well as patients attending outpatients Department of Radiology, Katihar. Medical College, Katihar Anteroposterior and lateral view of Right elbow joint was taken, appearance and fusion of ossification centers around this joint studied. Data was tabulated and statistically analysed by using STATA 12.0 TX, USA.

Results: From the analysis, it is found that in males at the age of 16 years, ossification centers around the elbow joint is fused except medial epicondyle and in females, it is completely fused.

Conclusion: From this radiological study, when findings are compared with the other authors from different states of India and in addition with other nations and observed to Fluctuate substantially.

Keyword: Elbow Joint, Ossification Center.

Introduction

Determination of the age of an individual from the appearance and fusion of ossification centers is a well-accepted fact in the field of medical and legal professions. The bones of human skeleton develop from separate ossification centers. From these centers, ossification progresses, till the bone is completely formed. These changes can be studied by means of X- ray. It is therefore possible to determine the approximate age of an individual by radiological examinations till ossification is complete. The skeletal system develops from Paraxial and Lateral plate mesoderm. [1] .

Ossification center of the bones fuses during age periods which are remarkably constant for a particular epiphysis. [2] Ossification center of the bone fuses at the particular age and this is helpful in age

determination. In law the crime and punishment is entirely based on criminal responsibility and this in turn depends on the age of a person. [3] Age is helpful in identification of an individual which in turn is helpful in both civil and criminal cases. [4] It has been also stated that the study of fusion of ossification center of bones is considered a reasonable scientific and accepted method for age determination by the law courts all over the world. [5]

Hepworth S.M. (1929) was first one to conduct work on fusion of ossification centers in India. He compared the data with data of other countries and concluded that Indians are ahead of English and American people. Sidhom G. studied fusion in Egyptian boys and concluded that age of fusion is similar to boys of Australia. [6,7]

Mehta H.S. (1963) stated that from puberty to the consolidation of skeleton (about 18 years in girls and about 20-21 year in boys) fairly close estimation within a margin of two years may be made mainly on the progress of the fusion of ossification centers. [8,9]

The Indian population differs widely from the western population in hereditary, dietary, socio-economic and ethnic factors. Studies done in India, Hepworth (Punjabis) in 1929, Galstaun (Bengalis) in 1930 and 1937, Pilliai (Madarasis) in 1936, Basu & Basu (Bengalis) in 1938, Agarwal and Pathak (Punjabis) in 1957, Bajaj (Delhi) in 1967, Jit (Punjabis) in 1971 and Nambi (Madarasis) in 2008. [6,10-16] Which were all based on the fusion of ossification centers, which was used for age determination after 12 years. Skeletal maturity is affected by various factors that are genetic and environmental in origin. [17] Genetically determined pattern of skeletal maturity can also be altered by environmental factors as well. Climate is a factor that can alter the pattern of skeletal maturation and eventually the physical growth. It is not uncommon to see poor nutrition, low temperature and hypoxia lead to delay maturity in high altitudes. [18-20].

Material & Methods

- **Study design:** Cross-sectional study.
- **Sample size:** 300 subjects (168 Males & 132 Females)

$$(n = z^2 pq / d^2)$$

Where –

n = sample size

z = 1.96 (considering 0.05 alpha, 95% confidence limits and 80% beta)

p = assumed probability of occurrence or concordance of results

q = 1 – p

d = marginal error (precession)

- **Duration of study:** Jan 2021 to Dec. 2021.
- **Study Center:** Department of Anatomy & Radiology, Katihar Medical College, Katihar.

Inclusion Criteria:

- Apparently normal healthy individuals of age between 10 to 19 yrs.
- Individuals who have documentary evidence for date of birth.
- Individuals who have documentary evidence for native of North Bihar

Exclusion Criteria:

- Any chronic illness eg. Congenital heart disease, rheumatoid arthritis, tuberculous arthritis.
- Any blood disorders like hemophilia, sickle cell anemia, thalessemia.
- Endocrine diseases.
- Severe malnutrition.
- Short stature.
- Chronic drug intake eg. - Antiepileptic, steroid.
- Radiation therapy or trauma

Methods:

- Subjects: School students, 1st year MBBS students of Katihar Medical College, Katihar & OPD patients of Radiology Department.
- History of subjects were taken, height and weight of subjects were recorded.
- 9 groups as 10-11, 11-12, 12-13, 13-14, 14-15, 15-16, 16-17, 17-18, and 18-19 years according to their ages.
- Subjects were X-rayed for right elbow joint in AP and lateral view.

Results

Table 1: Showing distribution of no. of subjects and their percentage according to age and sex

Age (In Yrs)	No. of Cases		Total	Percentage (%)	
	Male	Female		Male	Female
10-11	10	9	19	6	6.8
11-12	4	8	12	2.4	6.1
12-13	6	13	19	3.6	9.8
13-14	20	11	31	11.9	8.3
14-15	8	18	26	4.8	13.6
15-16	19	9	28	11.3	6.8
16-17	23	13	36	13.7	9.8
17-18	64	43	107	38.1	32.6
18-19	14	8	22	8.3	6.1
Total	168	132	300	100	100

Table 1 showing distribution of number of subjects and their percentage according to age and sex. Out of 300 cases 168 were males and 132 were females. Maximum number of cases were observed in 17-18 years age group in which 38% were males and 32.6% were females.

Table 2: Showing age of appearance of medial epicondyle of lower end of humerus

Age (Yrs)	No. of Cases		Number of cases showing complete appearance		Percentage (%)	
	Male	Female	Male	Female	Male	Female
10-11	10	9	10	9	100	100
11-12	4	8	4	8	100	100
12-13	6	13	6	13	100	100
13-14	20	11	20	11	100	100
14-15	8	18	8	18	100	100
15-16	19	9	19	9	100	100
16-17	23	13	23	13	100	100
17-18	64	43	64	43	100	100
18-19	14	8	14	8	100	100

Table 2 showing age of appearance of medial epicondyle of lower end of humerus. In all cases we have observed the appearance of ossification center for medial epicondyle.

Table 3: Showing age of fusion of medial epicondyle of humerus with shaft

Age (Yrs)	No. of cases		Number of cases showing complete fusion		Percentage (%)	
	Male	Female	Male	Female	Male	Female
10-11	10	9	0	0	0.0	0.0
11-12	4	8	0	0	0.0	0.0
12-13	6	13	0	0	0.0	0.0
13-14	20	11	0	3	0.0	30.0
14-15	8	18	0	11	0.0	61.0
15-16	19	9	8	9	40.0	95.0
16-17	23	13	21	13	90.0	100.0
17-18	64	43	64	43	100.0	100.0
18-19	14	8	14	8	100.0	100.0

χ^2= 222.87, p ≥0.009

Table 3 showing age of fusion of secondary ossification center for medial epicondyle of lower end of humerus. Majority of cases (≥80%) were showing fusion, at the age of 16-17 years in males and 15-16 years in females. The complete fusion was observed in 100% cases at the age of 17-18 years in males and 16-17 years in females. That is statistically significant p ≥ 0.009.

Table 4: Showing age of appearance of olecranon process of ulna

Age (In Yrs)	No. of cases		Number of cases showing appearance		Percentage (%)	
	Male	Female	Male	Female	Male	Female
10-11	10	9	2	8	20	88.88
11-12	4	8	3	8	80	100
12-13	6	13	6	13	100	100
13-14	20	11	20	11	100	100
14-15	8	18	8	18	100	100
15-16	19	9	19	9	100	100
16-17	23	13	23	13	100	100
17-18	64	43	64	43	100	100
18-19	14	8	14	8	100	100

χ^2= 124.55, p ≥0.0001

Table 4 showing age of appearance of secondary ossification center for olecranon process of ulna. Majority of cases (≥80%) were showing appearance at the age of 11-12 years in males and 10-11 years in females. The complete appearance was observed in 100% cases at the age of 12-13 years in males and 11-12 years in females. That is statistically significant p ≥0.0001.

Table 5: Showing average age (Incidence of fusion ≥80%) of fusion of secondary ossification centers around elbow joint

Parameters	Male (Yrs)	Female (Yrs)
Medial epicondyle	16-17	15-16
Lateral epicondyle	14-15	12-13
Olecranon process of ulna	15-16	14-15
Head of radius	15-16	14-15

Table 5 showing average age of fusion of secondary ossification centers around elbow joint. All the secondary ossification centers around elbow joint were fused at the age 16-17 years in males and 15-16 years in females

Discussion

Table 1: Comparison of ages (Yrs) of appearance and fusion of ossification center around Elbow joint given by various workers in India with findings of present study

Ossification Centers		Hepworth (1929) Pubjabis (Yrs)	Lal & Nat (1934) Male of U.P. (Yrs)	Pillai (1936) Madrasis (Yrs)	Galstaun (1937) Bengalis		Basu & Basu (1938) Bengali Hindu Female (Yrs)	Lal & Townsend (1939) Female of U.P. (Yrs)	Present Study (2021) Bihar.	
					Male (Yrs)	Female (Yrs)			Male (Yrs)	Female (Yrs)
Medial Epicondyle (Fusion)		16	14	13-14	14.5	14-15	15-17	14-17	16-17	15-16
Lateral Epicondyle	Appearance	12	10	-	-	-	-	-	12-13	11-12
	Fusion	11-16	10-12	12-13	14-15	-	-	13-14	14-15	12-13
Olecranon Process of Ulna	Appearance	11-13	9-12	-	-	-	-	-	11-12	10-11
	Fusion	17	15	13-14	-	15	16	14-16	15-16	14-15
Head of Radius (Fusion)		16	14	13-14	14-15	16	17	14-17	15-16	14-15

Table 2: Comparison of ages (yrs) of appearance and fusion of ossification center around Elbow joint given by various workers from other countries with findings of present study.

Ossification Centers		Davies & Parsons (1927) Englanders (Yrs)	Flecker (1932) Australians		Frazer (1958) Europeans		Gray (1995) Europeans		Present Study (2021) Bihar	
			Male (Yrs)	Female (Yrs)	Male (Yrs)	Female (Yrs)	Male (Yrs)	Female (Yrs)	Male (Yrs)	Female (Yrs)
Medial Epicondyle (Fusion)		20	16	15	18	15	20	-	16-17	15-16
Lateral Epicondyle	Appearance	12	12	11	11	10	12	-	12-13	11-12
	Fusion	16	13	13	17	14	16	14	14-15	12-13
Olecranon Process of Ulna	Appearance	-	10	8	10	8	11	9	11-12	10-11
	Fusion	17	16	15	16- 17	14-15	16	14	15-16	14-15
Head of Radius (Fusion)		15-16	16	14	14-15	17 -18	17	14	15-16	14-15

Conclusion

- The ages of appearance and fusion of ossification centers were found earlier in females than in males.
- Ossification centers around elbow joint can be used for age estimation among the adolescents.
- Benchmark for other researchers in this region to take a cue out of it.

- Helpful for medico-legal cases.
- Helpful for clinician.
- Prediction of final adult height.
- Important research tool for physical anthropologists to know discrete patterns of maturation.
- Our successors can endeavor to initiate a similar study taken into its lap more number of cases and wider age range.

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