

An Observational Study of Correlation between Age Determinations from Radiological Examination of Wrist in Relation to Birth Certificates in 16-20 Years Age Group

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Abstract— *Background: In medico legal practice we frequently come across cases of age estimation, especially to find out whether the individual is minor or major age group. Material and Method: In this study 109 subject of age group 16-20 years were radiographed for wrist joint from April 2021 to March 2022 in J.L.N. Medical College Ajmer. Obtained data of fusion of lower end of radius and ulna is analysed and reviewed with respect to physical development and reliable document of date of birth. Results: Out of 109 cases 64.22% (70 cases) were of females while 35.78%(39 cases) were of males of age group 16-20 years. Among female cases(56) in 16-18 years age group showed epiphyseal fusion of lower end of radius 28.57% (16 cases), in process of fusion 48.21%(27 cases) while non fusion in 23.21%(13 cases) and in 18-20 age group(14 cases) all cases showed epiphyseal union. Among female cases(56) in 16-18 years age group showed epiphyseal fusion of lower end of ulna 60.70% (34 cases), in process of fusion 8.92%(5 cases) while non fusion in 30.35%(17 cases) and in 18-20 age group(14 cases) all cases showed epiphyseal union. Among male cases(39) in 18-20 years age group showed epiphyseal fusion of lower end of radius 84.61% (33 cases), in process of fusion 10.24%(4 cases) while non fusion in 5.12%(2 cases) while epiphyseal fusion of lower end of ulna showed in 89.74% (35 cases), in process of fusion 10.24%(4 cases).*

Keywords— *Age determination, ossification centre, physical development, secondary sexual characters.*

I. INTRODUCTION

Age estimation in the living is one of the most important tasks especially in developing countries like India where birth records are often not well maintained. Despite the fact that there are a number of laws requiring registration of births viz. Registration of Births and Deaths Act 1969, most births are not properly recorded. There is a variation in the timing of appearance and fusion of the epiphyses of the bones. Ossification is seen earlier in the tropical countries and in females. The variation in the age of appearance and the union of ossification is mainly attributed to various factors like climate, heredity, race, nutrition, dietary habits, gender and socioeconomic status of population. Scientific estimation of age of an individual whether living, dead or

from human remains is a vexing problem for personnel in Forensic Medicine in both civil and criminal matters.

Estimation of age is an important task and a valuable tool to assist in many civil and criminal procedures such as identification, consent, criminal responsibility, clinical examination, validity of will, attainment of majority, kidnapping, rape, criminal abortion etc. Especially in developing countries like India where majority of population is not aware of the importance of registration of births or the record of registration may not be properly maintained. The parameters used for estimation of age are mainly physical examination, dental examination and radiological examination. Physical examinations are not sufficiently accurate due to the wide variations in biological maturation in different individuals.

II. AIM AND OBJECTIVES

AIM

To study the age determination by radiological examination of fusion of epiphyseal centres of Elbow and wrist joints in relation to birth certificates in subjects between 16-20 years of age.

OBJECTIVES

1. To assess the age determination from fusion of epiphyseal centres of Elbow and wrist joints in subjects between 16-20 years of age using digital X-rays in Ajmer region.
2. To assess and compare radiological age to the documented age as per the birth certificate.
3. Suggestions for authenticity of age estimation from ossification centres, physical and dental examination.

III. MATERIAL & METHOD

This study will be carried out at the Department of Forensic Medicine, JLN Medical college, Ajmer with assistance from Department of Radiology, for radiological examination after obtaining due clearance from research and review board of JLN Medical College and Hospital, Ajmer.

Study design: Community based Descriptive Observational Study.

Study period: 1st April, 2021 to 31st March, 2022 or Until the Sample Size is achieved; whichever is earlier.

Study universe: Students and staff of Medical, nursing & other paramedical college as well as students from academic institutions of Ajmer between the age group of 16-20 years with reliable document of date of birth.

Inclusion criteria:

- Should belong to Rajasthan by origin or staying for last 10 years in the Ajmer region.
- Only Subjects who have documentary evidence of age in the form of birth certificate issued by Nagar Nigam & competent authority and matriculation certificate.
- Age group: 16-20 years.
- Subjects who give their consent for participation in the study.

Exclusion criteria:

- Subjects without proof of birth record.
- Subjects below 16 years and above 20 years.
- Subjects with Severe malnutrition.

- Subjects with Chronic illness.
- Subjects with Endocrinal disorders.
- Subjects with deformities of limbs and pelvis.

Method of collection of data:

After obtaining consent from the subjects satisfying the inclusion criteria and obtaining valid informed written consent, the general physical examination will be conducted to know the health status and rule out any deformities to select the subjects after applying exclusion criteria.

Materials:

- Printer black ink
- Data collecting instrument, X-ray film
- Lead marker, lead apron
- 8 x 10 inches rigid cassette
- Film hanger (8" x 10")
- Developer Solution
- View box
- Magnifying lens
- Weighing machine and height measuring scale
- Performa

Sampling method:

- Stratified Random Sampling based on age.
- Sample size – 109(Boys 39 sample and girls 56+14=70)
- **Computing sample size for Females**

• Previous studies tell us that 75 % cases of epiphysial union occurs in specified 16-18 year period.

Precision=we'd like the result to be within 10% of true value.

Confidence level: convention=95%=1- α

$\alpha = 0.05$; $Z(1- \alpha /2)$ one tailed test=1.65 in practice of forensic medicine research is going on over fusion of epiphysis so upper end is taken for consideration

Corresponding to significance level of 0.05

$p= 0.75$ whereas $q = 1-p=0.25$

Plugging all values in formula

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

$= (1.65)^2(.75)(.25)/(0.1)^2=51.04=51$ sample

10% extra sample for Geographical variation (previous studies not being conducted in Ajmer) =56 sample

• Previous studies tell us that 95 % cases of epiphysial union occurs in specified 18-20 year period.

Precision=we'd like the result to be within 10% of true value.

Confidence level: convention=95%=1- α

$\alpha = 0.05$; $Z(1 - \alpha / 2)$ one tailed test=1.65 in practice of forensic medicine research is going on over fusion of epiphysis so upper end is taken for consideration

Corresponding to significance level of 0.05

$p = 0.95$ whereas $q = 1 - p = 0.05$

Plugging all values in formula

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

$$= (1.65)^2 (.95)(.05) / (0.1)^2 = 12.93 = 13 \text{ sample}$$

10% extra sample for Geographical variation (previous studies not being conducted in Ajmer) =14 sample

• **Computing sample size for Males**

• Previous studies tell us that 85 % cases of epiphysial union occurs in specified 18-20 year period.

Precision=we'd like the result to be within 10% of true value.

Confidence level: convention=95%=1- α

$\alpha = 0.05$; $Z(1 - \alpha / 2)$ one tailed test=1.65 in practice of forensic medicine research is going on over fusion of epiphysis so upper end is taken for consideration

Corresponding to significance level of 0.05

$p = 0.8$ whereas $q = 1 - p = 0.20$

Plugging all values in formula

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

$$= (1.65)^2 (.85)(.15) / (0.1)^2 = 34.71 = 35 \text{ sample}$$

10% extra sample for Geographical variation (previous studies not being conducted in Ajmer) =39 sample

Method

After selection of cases, the personal details will be recorded and after taking informed written consent clinical and dental examination will be carried out and details recorded in pre-proposed Performa. The subjects will then be subjected to Digital X-ray examination of Wrist and Elbow joints. The Radiographs will then be studied for appearance and fusion of ossification centres and age determination will be done on basis of the table of Galustan in Modi's textbook of Medical Jurisprudence. The documented age of the subject will also be noted and the determined age will be analysed in relation to the documented age (as per birth certificates).

Statistical analysis

The finally analysed data would then be tabulated in Microsoft Excel Worksheet and statistically analysed using appropriate statistical software to determine its significance at 95% confidence limits. The collected qualitative data will be expressed in groups, diagrams, proportion and percentages and analysed using appropriate statistical tests. The quantitative data will be expressed in linear and standard deviation and analysed by appropriate statistical tests as per the data obtained. Continuous data would be expressed in form of proportion and percentages differences in proportion would be analysed using chi square test. $P < 0.05$ will be considered significant.

IV. RESULT AND OBSERVATION

In our study the majority of cases (54%) were between 18-20 years of age as per their birth certificates. Males were more (55.55%) amongst 18-20 years subjects and females were more (56.52%) amongst 16-18 year subjects.. Majority of subjects from rural region were males (62.31%) and those from urban regions were mostly females (60.49%).

Gender wise distribution of epiphyseal fusion of lower end of radius (n=150)

Epiphysis	Male (Years)		Female (Years)		Total
	16-18	18-20	16-18	18-20	
Non-Fused	13 (43.33%)	00 (0%)	16 (41.02%)	00 (0%)	29 (19.33%)
Process of Fusion	13 (43.33%)	03 (6.66%)	19 (48.71%)	00 (0%)	35 (23.33%)
Fused	04 (13.33%)	42 (93.33%)	04 (10.25%)	36 (100%)	86 (57.33%)
Total	30 (40%)	45 (60%)	39 (52%)	36 (48%)	150 (100%)

Gender wise distribution of epiphyseal fusion of lower end of ulna

(n=150)

Epiphysis	Male (Years)		Female (Years)		Total
	16-18	18-20	16-18	18-20	
Non-Fused	14 (46.66%)	00 (0%)	14 (35.89%)	00 (0%)	28 (18.66%)
Process of Fusion	13 (43.33%)	02 (4.44%)	03 (7.69%)	00 (0%)	18 (12%)
Fused	03 (10%)	43 (95.55%)	22 (56.41%)	36 (100%)	104 (69.33%)
Total	30 (40%)	45 (60%)	39 (52%)	36 (48%)	150 (100%)

Table 1: Gender and Age Group wise fusion of distal end of ulna with its shaft

Age group (Years)		Male				Female				p value
		N (%)	P (%)	C (%)	T (%)	N (%)	P (%)	C (%)	T (%)	
11-12	Right	11(100)	0(0)	0(0)	11(100)	12(100)	0(0)	0(0)	12(100)	NA
	Left	11(100)	0(0)	0(0)		12(100)	0(0)	0(0)		
12-13	Right	13(100)	0(0)	0(0)	13(100)	13(100)	0(0)	0(0)	13(100)	NA
	Left	13(100)	0(0)	0(0)		13(100)	0(0)	0(0)		
13-14	Right	11(100)	0(0)	0(0)	11(100)	21(100)	0(0)	0(0)	21(100)	NA
	Left	11(100)	0(0)	0(0)		21(100)	0(0)	0(0)		
14-15	Right	15(100)	0(0)	0(0)	15(100)	14(100)	0(0)	0(0)	14(100)	NA
	Left	15(100)	0(0)	0(0)		14(100)	0(0)	0(0)		
15-16	Right	10(100)	0(0)	0(0)	10(100)	15(65.2)	4(17.4)	4(17.4)	23(100)	0.101
	Left	10(100)	0(0)	0(0)		15(65.2)	4(17.4)	4(17.4)		
16-17	Right	16(64)	5(20)	4(16)	25(100)	3(18.8)	5(31.2)	8(50)	16(100)	0.013
	Left	16(64)	5(20)	4(16)		3(18.8)	5(31.2)	8(50)		
17-18	Right	0(0)	4(21.1)	15(78.9)	19(100)	0(0)	0(0)	18(100)	18(100)	0.004
	Left	0(0)	4(21.1)	15(78.9)		0(0)	0(0)	18(100)		
18-19	Right	0(0)	0(0)	10(100)	10(100)	0(0)	0(0)	14(100)	14(100)	NA
	Left	0(0)	0(0)	10(100)		0(0)	0(0)	14(100)		
19-20	Right	0(0)	0(0)	11(100)	11(100)	0(10)	0(0)	10(100)	10(100)	NA
	Left	0(0)	0(0)	11(100)		0(10)	0(0)	10(100)		
20-21	Right	0(0)	0(0)	14(100)	14(100)	0(0)	0(0)	16(100)	16(100)	NA
	Left	0(0)	0(0)	14(100)		0(0)	0(0)	16(100)		

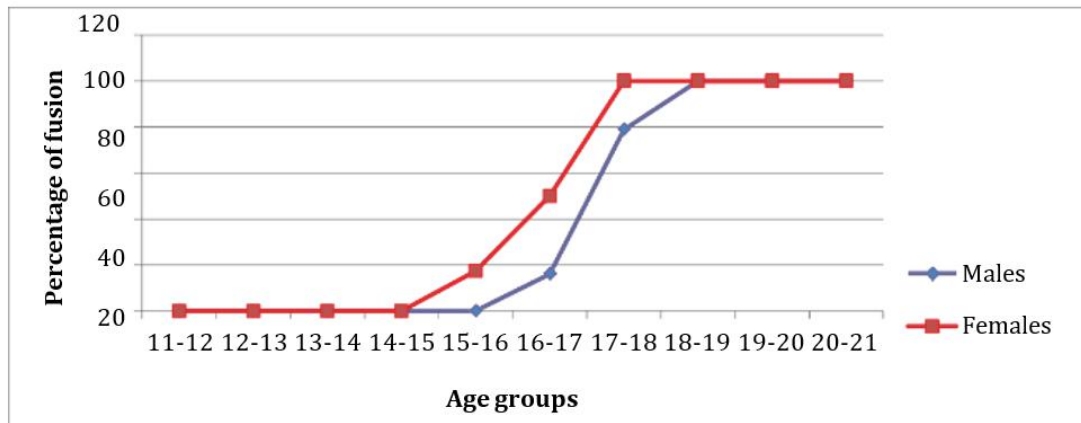


Fig-1: Complete Epiphyseal Fusion of distal End of Ulna

Table 2: Gender and Age Group wise fusion of distal end of radius with its shaft

Age group (Years)		Male			Female			p value		
11-12	Right	11(100)	0(0)	0(0)	11(100)	12(100)	0(0)	0(0)	12(100)	NA
	Left	11(100)	0(0)	0(0)		12(100)	0(0)	0(0)		
13-14	Right	13(100)	0(0)	0(0)	11(100)	13(100)	0(0)	0(0)	13(100)	NA
	Left	13(100)	0(0)	0(0)		13(100)	0(0)	0(0)		
14-15	Right	11(100)	0(0)	0(0)	15(100)	21(100)	0(0)	0(0)	14(100)	NA
	Left	11(100)	0(0)	0(0)		10(100)	21(100)	0(0)		
15-16	Right	15(100)	0(0)	0(0)	25(100)	14(100)	0(0)	0(0)	16(100)	0.033
	Left	15(100)	0(0)	0(0)		14(100)	0(0)	0(0)		
17-18	Right	10(100)	0(0)	0(0)	19(100)	16(69.6)	3(13.0)	4(17.4)	18(100)	0.008
	Left	10(100)	0(0)	0(0)		16(69.6)	3(13.0)	4(17.4)		
18-19	Right	16(64.0)	2(8.0)	7(28.0)	11(100)	4(25)	5(31.2)	7(43.8)	10(100)	NA
	Left	16(64.0)	2(8.0)	7(28.0)		4(25)	5(31.2)	7(43.8)		
20-21	Right	2(10.6)	7(36.8)	10(52.6)	14(100)	0(0)	0(0)	15(100)	16(100)	NA
	Left	2(10.6)	7(36.8)	10(52.6)		0(0)	0(0)	15(100)		

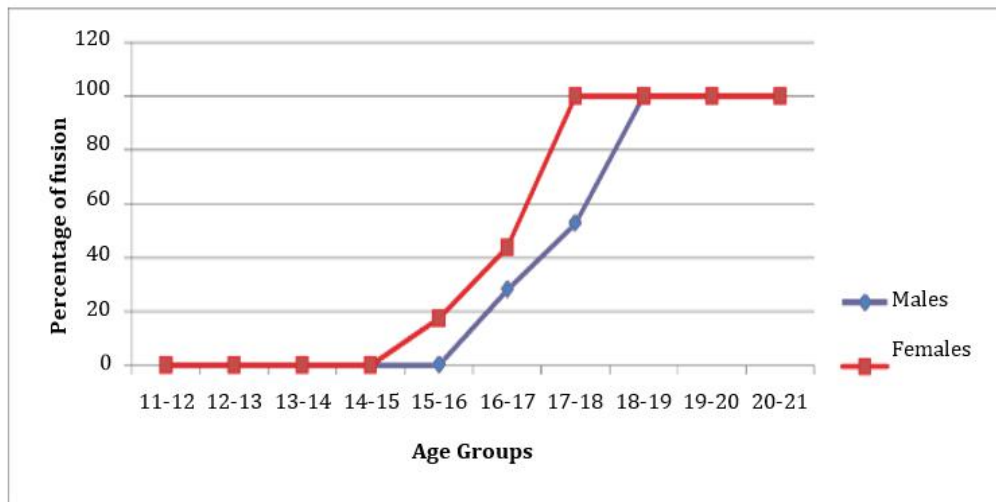


Fig-2: Complete Epiphyseal fusion of distal end of radius

V. DISCUSSION

In the present study, epiphyseal fusion of the lower end of radius and ulna in the males and females was evaluated and the results were compared with the previous studies. It was observed in our study that complete fusion of distal end of ulna with shaft was seen in the age group of 16-17 years in males and 15-16 years in females and 100% complete epiphyseal fusion was noticed at the age of 18-19 years in males and 17-18 years in females. Similarly, complete fusion of lower end of radius was seen in females in the age group 15-16 years, and in males in the age group of 16-17 years. All the cases i.e. 100% complete fusion of lower end of radius was seen in the age group of 18-19 years in males and 17-18 years in females.

The result of this study is in agreement with previous studies from Marwar [9] and Davangere [10]. On the other hand, authors from England and Manchester observed fusion of distal end of ulna at 20 and 21 years respectively [11, 12]. Another study by Flecker from Melbourne is also in concordance with our observations [13]. Fusion of lower end of ulna was delayed by 1 year in the study in Marwar region among females [9].

VI. CONCLUSION

Age estimation is an important exercise undertaken in clinical forensic medicine for various civil & criminal purposes.

The epiphyses around the elbow joint were completely fused in 97.33% study subjects by the age of 16 years in both males and females.

Complete fusion of lower end of Radius and Ulna were observed at 18 years of recorded age in the present

study in both genders.

The epiphyseal union of iliac crest was completed by the age of 20 years in both genders. The commencement of the epiphyseal union of iliac crest and ischial tuberosity was not observed before 18 years of age in this study.

Non-correlation of skeletal age to recorded age as per birth certificates was seen in 36% males and 16% females. Higher discrepancy was observed in rural subjects, non-vegetarian eaters and sports persons. Their skeletal age was ahead of their recorded ages. Due to variations in development of children, improved nutrition, physical changes, social pattern, changes in hormonal development, such studies must be done from time to time.

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