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Original Research Article

Age Determination from Radiological Investigation of Epiphyseal Appearance and Fusion around Wrist Joint: A Cross-Sectional Study from Khammam Region

Sanjeev Krishnamoorthy[1], O. Murugesa Bharathi[2], Rajesh D.R.[3], Roop Kumar[4], Abhishek Singh[5], Hitesh Chawla[6]
[1]Assistant Professor, Department of Forensic Medicine, SRM Medical College & Research Center, Tamil Nadu
[2]Assistant Professor, Department of Forensic Medicine, Indira Gandhi Medical College & Research Institute, Puducherry
[3]Assistant Professor, Department of Forensic Medicine, Indira Gandhi Medical College & Research Institute, Puducherry
[4]Associate Professor, Department of Forensic Medicine, Sri Venkateshwara Medical College, Ariyur, Puducherry
[5]Assistant Professor, Department of Community Medicine, SHKM Govt. Medical College, Mewat, Haryana
[6]Assistant Professor, Department of Forensic Medicine, SHKM Govt. Medical College, Mewat, Haryana

***Corresponding author**
Dr Abhishek Singh
Email: abhishekparleg@gmail.com

Abstract: Determination of the age of an individual from the appearance and the fusion of the ossification centers is considered a reasonable well accepted method in the field of medical and legal professions. The challenges encountered while determining the age of a bone vary from place to place depending on the geographic terrain, climatic, dietetic, hereditary, disease & other factors. Therefore aim of this study was to ascertain status of epiphyseal fusion of long bones at wrist joint for determination of age. The study comprised of a total 296 subjects in the age groups from 11 to 21 years from Khammam region. X-rays of the both elbow joints and bilateral wrist joint were taken in antero-posterior view. The films were studied radiologically by interpreting the ossification into stages. Complete fusion of distal end of ulna with its shaft was seen in the age group of 16-17 years in males and 15-16 years in females and 100% complete epiphyseal fusion at wrist joint was noticed at the age of 18-19 years in males and 17-18 years in females. Ages of bilateral complete union of epiphysis around wrist joint i.e. for lower end of radius and ulna both, it is found to be 17-18 years for girls &18-19 years for boys in Khammam region.
Keywords: age estimation, radiology, epiphysis, fusion, wrist joint, and region.

INTRODUCTION

Determination of the age of an individual from the appearance and the fusion of the ossification centers is considered a reasonable scientific method and a well-accepted fact in the field of medical and legal professions [1]. It is a common practice that doctors are called upon in the court of law to give expert opinion about age of the person. On the other hand, comment on age of bones in mutilated skeletal remains poses a challenge to a forensic expert. Hence determination of age presents a task of considerable importance from the view-point of the administration of justice [2, 3].

The bones of human skeletons develop from separate ossification centers. From these centers ossification progresses till the bone is completely formed. It is therefore possible to determine the approximate age of an individual by radiological examination of bones till ossification is complete. The challenges encountered while determining the age of a bone vary from place to place depending on the geographic terrain, climatic, dietetic, hereditary, disease &other factors [4]. In view of the same, a survey committee while reporting on medico-legal practice recommended to the Government of India in the year 1964 that a zone wise study for the problem of determination of age is to be encouraged [5].

According to best of my knowledge status of epiphyseal fusion of long bones at wrist joint for determination of age has not been closely investigated by the forensic experts in the region of Khammam till date. Therefore present study was planned to conduct with an objective to analyze and ascertain status of epiphyseal fusion of long bones at wrist joint for determination of age. An additional objective was to determine differences of epiphyseal fusion of long bones at wrist joint in both the genders and both sides.

MATERIALS AND METHODS

The present cross sectional study was planned and executed by the Department of Forensic Medicine, MAMATA medical college, Khammam. The study population consisted of volunteers from nearby schools, medical and para-medical courses. Only subjects with known date of birth (duly verified from the birth certificates/school admission records/matriculation certificate) and those apparently normal and healthy individuals were included in the study. Cases with unknown exact date of birth and those having any chronic illness, apparent skeletal deformity/ malformation were excluded from the survey.

The study comprised of a total number of 296 subjects in the age groups from 11 to 21 years from Khammam region. The volunteers were divided in ten groups according to the age. i.e. 11 -12 years; 12 -13 years; 12 -13 years; 13 -14 years; 14 -15 years; 15 -16 years; 16 -17 years; 17 -18 Years; 18-19 years; 19-20 years; 20-21 years. Proforma was devised to collect all relevant information of volunteers. The information regarding particulars of the subject like name, age, sex, height, weights were included. Then subjects were then taken for radiological examination. Subjects were made to wear the lead apron, and then seated on a stool of convenient height. X-rays of the both elbow joints and bilateral wrist joint were taken in antero-posterior view. The films were studied radiologically by interpreting the ossification into three stages [6] as follows: Bones showing no epiphyseal fusion (N), Bones showing partial fusion i.e. in the process of fusion (P), Bones showing complete fusion (C). The age of epiphyseal fusion was taken as the youngest age group in which complete fusion was noticed in all (100%) of the subjects.

Written informed consent was obtained in the local language from every study subject before conducting each interview. They were explained about the nature and purpose of study and requested to participate. Ethical committee approved the study. The collected data was coded and entered in Statistical Package for Social Sciences (SPSS), version 20. The results were expressed as proportions. Chi-square (χ^2) test was applied to test the difference across the groups and $p<0.05$ was considered statistically significant.

RESULTS

The X-ray films of 296 subjects of the wrist joint were studied for fusion of the lower end of radius and ulna with its shaft. Complete fusion of distal end of ulna with its 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. (Table 1) (Figure 1)

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. (Table 2) (Figure 2)

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)		

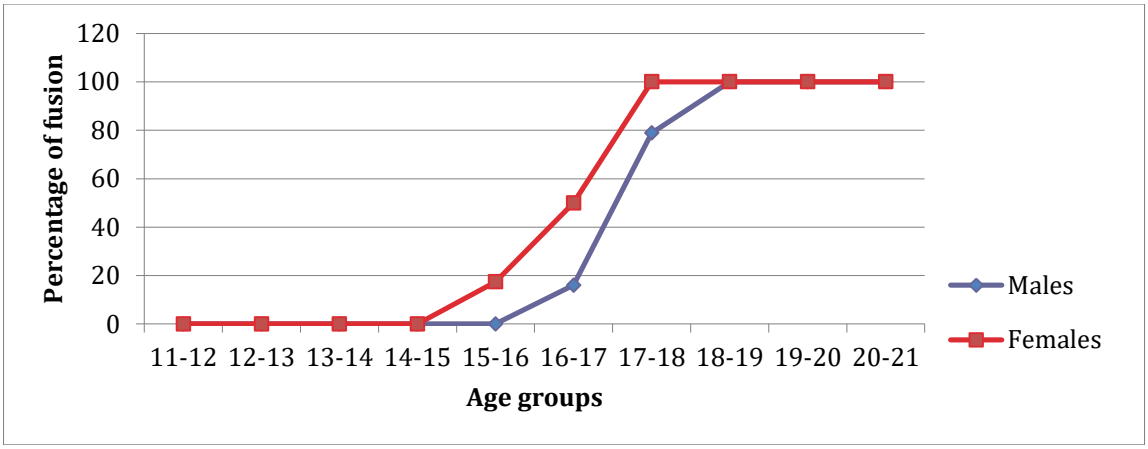

Fig-1: Complete Epiphyseal Fusion of distal End of Ulna

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

Age group (Years)		Male				Female				p value
		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)	16(69.6)	3(13.0)	4(17.4)	23(100)	0.145
	Left	10(100)	0(0)	0(0)		16(69.6)	3(13.0)	4(17.4)		
16-17	Right	16(64.0)	2(8.0)	7(28.0)	25(100)	4(25)	5(31.2)	7(43.8)	16(100)	0.033
	Left	16(64.0)	2(8.0)	7(28.0)		4(25)	5(31.2)	7(43.8)		
17-18	Right	2(10.6)	7(36.8)	10(52.6)	19(100)	0(0)	0(0)	15(100)	18(100)	0.008
	Left	2(10.6)	7(36.8)	10(52.6)		0(0)	0(0)	15(100)		
18-19	Right	0(0)	0(100)	10(100)	10(100)	0(0)	0(0)	14(100)	14(100)	NA
	Left	0(0)	0(100)	10(100)		0(0)	0(0)	14(100)		
19-20	Right	0(0)	0(0)	10(100)	11(100)	0(0)	0(0)	10(100)	10(100)	NA
	Left	0(0)	0(0)	10(100)		0(0)	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)		

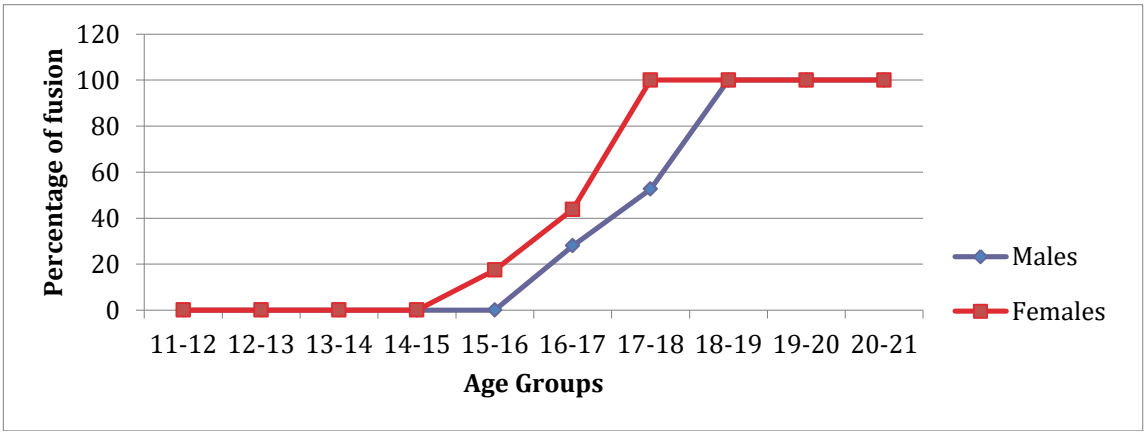

Fig-2: Complete Epiphyseal fusion of distal end of radius

Table 3: Gender wise comparison of epiphyseal fusion of lower end of ulna and radius with its shaft with previous studies

Age of fusion of distal end of ulna (in years)		
Study	**Gender**	
	Male	**Female**
Indian Studies		
Hepworth (Punjab- 1927) [7]	16-17	16-17
Pillai (1936) [8]	18	18
Kothari (Marwar-1974) [9]	18-19	18-19
Sunil & Viswanathan (2012-Davanagere) [10]	18-19	15-16
Present Study (Haryana-2014)	**18-19**	**17-18**
Foreign Studies		
Davies and Pearson (England -1929) [11]	20	20
Paterson (Manchestor-1929) [12]	21	20
Flecker (Melbourne-1931) [13]	19	17
Sidhom and Derry (Egypt -1931) [14]	19-20	-----
Age of fusion of distal end of radius (in years)		
Indian Studies		
Hepworth (Punjab- 1927) [7]	16-17	16-17
Pillai (Madrasi-1936) [8]	18	18
Kothari (Marwar-1974) [9]	18-19	18-19
Bhise and Nanandkar (Mumbai-2010) [15]	16-17	15-16
Present Study (Haryana-2014)	**18-19**	**17-18**
Foreign Studies		
Davies and Pearson (England -1929) [11]	19-20	19-20
Paterson (Manchestor-1929) [12]	21	20
Flecker (Melbourne-1931) [13]	19	18
Sidhom and Derry (Egypt -1931) [14]	19-20	----

DISCUSSION

In the present study, epiphyseal fusion of the lower end of radius and ulna in the males and females of Khammam region 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 its 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 Manchestor 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].

Fusion of lower end of radius was found to be 1 year earlier in the study conducted by Hepworth [7] in Punjabis and 1 year later by another author from Egypt [14]. Our findings confirm the results of another study from Mumbai (Table 3) [15].

This study has several strengths. First, we determined the current status of epiphyseal fusion of long bones at wrist joint for determination of age in the Khammam region. Very few similar experiences are available in the literature about the age estimation from ossification of wrist and elbow joint involving this particular region of India. Second, all the x- rays were read by a single person, which creates a sense of uniformity. The study has some limitations as well. For example, findings emerging out of the current study may not be extrapolated across India. Studies with bigger sample size are warranted to confirm our observations.

CONCLUSION

To conclude, the empirical evidences of the current study indicate that ages of union of epiphysis around wrist joint i.e. for lower end of radius and ulna both, it is found to be 17-18 years for girls &18-19 years for boys in the Khammam region. Studies with bigger sample size are warranted to confirm our observations in this part of India.

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