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Original Article

A ROENTGENOLOGICAL STUDY OF EPIPHYSEAL UNION AROUND LOWER END OF HUMERUS IN BOYS AND GIRLS OF CHITRADURGA REGION OF KARNATAKA

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ABSTRACT

Introduction: According to previous research on long bones worldwide, there is no consistent sequence for the ossification of long bones in different countries or regions within a single country. The current study was started with the aforementioned considerations in mind, as well as the fact that Chitradurga district has less such work done. In medicine, law, and public health, having exact understanding of the union of the lower end of the humerus will be beneficial.

Materials and Methods: In the Chitradurga area of central Karnataka, India, a radiological investigation of the lower end of the humerus was performed on a total of 97 males and 108 females in the age range of 11 to 20 years. The radiographs were thoroughly examined, and the results were noted.

Results: Fusion of the epiphyseal center of lateral epicondyle with the capitulum was observed between the age group of 13 to 14 years in males and11-12 years in females. Fusion of the Trochlea and capitulum was observed in females between the age group of 11 to 12 years and in males between the age group of 12 to 13 years. In males between the age group of 14 to 17 years and in females between the age group of 11 to 14 years there was fusion of the medial epicondyle with the shaft. In males aged 14 to 15 years and females aged 12 to 13 years fusion of conjoint epiphysis with the shaft was observed.

Conclusions: In comparison to males, females typically experience epiphyseal fusion 1- 3 years earlier.

Keywords : Epicondyle, Ossification, Humerus

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INTRODUCTION

Bone is essentially a highly vascular, living, constantly changing, and mineralized special connective tissue, remarkable for its characteristic growth mechanism. Bone serves various functions such as support, movement, sound transduction, protection, production, attachment, and storage in the body. The humerus is one of the long bones of the body present in the brachium region, forming the upper arm and joining it to the shoulder and forearm.

A long bone has two ends called Epiphysis and a middle section called Diaphysis. The age period during which bone epiphyses combine is remarkably stable for a specific epiphysis. In a range of medical and surgical disciplines, as well as in the medico-legal arena, it holds significant value. Knowledge of normal ossification is, therefore, important medically, as the size and relation of epiphysis vary with age. According to reports, law courts worldwide recognize the examination of the epiphyseal union of bones as a valid scientific technique for determining an individual's age.

Numerous states in India and overseas have conducted extensive research on the age of epiphyseal unions, and based on the findings of these studies, it is clear that there are variations in epiphyseal union ages not only between Indian states but also between foreign countries.

This difference is thought to be caused by dietary habits, genetics, metabolism, climate, and region. In light of the aforementioned information, this study was carried out to determine the epiphyseal union at the lower end of the humerus to estimate an individual's age. The results were compared to those of regional Indian and Western populations to address the gaps and scarcity of such data in the medical literature.

MATERIAL AND METHODS

In the Chitradurga district of Karnataka, 97 males and 108 females between the age group of 11 to 20 who were enrolled in I) Sri Jagadguru Mallilarjuna Murugharajendra English Medium School, II) Bapuji Public School, III) Sri Jagadguru Mallilarjuna Murugharajendra College of Pharmacy, and IV) Sri Jagadguru Mallilarjuna Murugharajendra Institute of Technology-Chitradurga were the subjects of the current study.Diagnosis of these cases is done by various methods, one of which is cytogenetics, an emerging field of science in which chromosomal structures are observed and analyzed, along with their properties and actions during cell division, whether in somatic cells or germ cells, and their roles in mitosis and meiosis. This helps to understand how chromosomes, or specifically, genes, influence the phenotype of an individual.

Random sampling technique was used to choose study participants. Consent was obtained from parents and students.

A thorough medical history, including all necessary information such as name, age, sex, food preferences, socioeconomic situation, and religion, was recorded in the proforma. Standard techniques were employed to record the subjects' height and weight. The age, with respect to their sex, was divided into 9 groups with a minimum of 10 individuals in each group.

The radiographs were taken using the digital Siemens system at the Radiodiagnosis department. The findings were confirmed by Radiologist Dr. Naveen Kumar. The Das Gupta, Vinod Prasad & Shamer Singh (1971) and Banerjee & Agarwal (1998) method of classification were followed during observation of the radiographs showing both complete and incomplete union at the lower end of the humerus.

RESULTS

In the age group of 11 – 12 years:

In males, the ossification center for the lateral epicondyle had not yet developed in 90% of cases, while it had in 10% of cases. In 100% of instances, the medial epicondyle and conjoint epiphyses were not fused with the shaft. Nine percent of the females in this age range had the medial epicondyle fused with the shaft. The lateral epicondyle, capitulum, and trochlea fused together to produce a conjoint epiphysis in 27.2% of the females; this conjoint epiphysis was not united with the shaft. The ossification center for the lateral epicondyle had not yet developed in 36.3% of the females, while it had in 63.6% of them.

In the age group of 12 – 13 years:

In 100% of the males, the medial epicondyle did not fuse with the shaft. The lateral epicondyle was visible in 70% of instances. In 10% of cases, the lateral epicondyle and capitulum were fused together. In 100% of the cases, the conjoint epiphysis was not fused with the shaft. Among the females, 30% of cases showed the union of the epiphysis of the medial epicondyle with the shaft. The conjoint epiphysis fused with the shaft in 30% of cases.

In the age group of 13 – 14 years:

Among the males in this age group, the epiphysis of the medial epicondyle did not fuse with the shaft in 100% of cases. The lateral epicondyle did not appear in 7.14% of cases. The capitulum fused with the trochlea but not with the shaft in 81.8% of cases. The capitulum fused with the lateral epicondyle in 63.6% of cases. Among the females in this age group, 64.2% of cases showed the epiphysis of the medial epicondyle not fused with the shaft. The conjoint epiphysis was fused to the diaphysis in 78.5% of cases. 35.7% of cases showed complete union with the diaphysis.

In the age group of 14 – 15 years:

Among males in this age group, 90% of cases showed the epiphysis of the medial

Age in years	No. of cases			L.E. + Cap.(not fused to Tro) (Not fused to shaft)		Cap + Tro (not fused to L.E.)(not fused to shaft)		L. E. + Tro + Cap (Not fused to shaft)		C.E. fused to shaft		M.E. fused to shaft		Cap + L.E.(not fused to Tro) fused to shaft		Cap + Tro (not fused to L.E.) fused to shaft	
	M	F	TOTAL	M	F	M	F	M	F	M	F	M	F	M	F	M	F
11-12	10	11	21	0	1	0	8	0	1	0	0	0	1	0	1	0	5
12-13	10	10	20	0	0	5	0	1	2	0	8	0	3	0	0	2	0
13-14	11	14	25	1	0	0	0	6	0	0	13	0	5	0	0	0	1
14-15	10	10	20	0	0	0	0	5	1	5	9	1	9	0	0	0	0
15-16	10	10	20	0	0	0	0	8	0	3	9	3	9	0	0	0	0
16-17	12	10	22	0	0	4	0	3	0	5	10	3	10	0	0	2	0
17-18	11	12	23	0	0	0	0	0	0	11	12	11	12	0	0	0	0
18-19	12	15	27	0	0	0	0	0	0	12	15	12	15	0	0	0	0
19-20	11	16	27	0	0	0	0	0	0	10	17	10	17	0	0	0	0
Grand total	97	108	205														

Table 1. The epiphyseal union at the lower end of humerus

Sl. No.	Epiphysis	Males	Females
1	Cap + L.E.	13 yrs 02 mon 18 days	11 yrs 14 days
2	Cap + Tro	12 yrs 01 mon 01 day	11 yrs 14 days
3	L.E. + Tro + Cap	12 yrs 06 mon 01 day	11 yrs 14 days
4	C.E. to shaft	12 yrs 06 mon 28 day	12 yrs 10 days
5	M.E. to shaft	11 yrs 21 days	11 yrs 04 mon 29 days
6	Cap + L.E. to shaft	12 yrs 06 mon 28 days	11 yrs 14 days
7	Cap + Tro to shaft	12 yrs 06 mon 28 days	11 yrs 04 mon 29 days

Table 2. Earliest age of union of different epiphysis

epicondyle and conjoint epiphysis not fused with the diaphysis. Only 10% of cases showed complete union with the diaphysis. Among the females in this age group, 90% of cases showed complete union of the epiphysis of the medial epicondyle and conjoint epiphysis with the shaft. The epiphysis of the medial epicondyle and conjoint epiphysis were not fused with the shaft in 10% of cases.

In the age group of 15 – 16 years:

Among males in this age group, 20% of cases showed the epiphysis of the medial epicondyle and conjoint epiphysis fused with the diaphysis. The lateral epicondyle, capitulum, and trochlea fused with each other but not with the shaft in 80% of cases; 20% of cases showed complete union with the shaft. Among females in this age group, 100% of cases showed complete union of the epiphysis of the medial epicondyle with the shaft. Also, the conjoint epiphysis showed complete union with the shaft in 100% of cases.

In the age group of 16 – 17 years:

Among males in this age group, 25% of cases showed the epiphysis of the medial epicondyle fused with the diaphysis; the conjoint epiphysis was united to the shaft in 41.66% of cases; 25% of cases showed complete union with the shaft. Among females in this age group, 100% of cases showed complete union of the epiphysis of the medial epicondyle with the shaft. Also, the conjoint epiphysis showed complete union with the shaft in 100% of cases.

Sl. No.	Epiphysis	Males	Females
1	Cap + L.E.	13 yrs 02 mon 22 days	11 yrs 04 mon 12 days
2	Cap + Tro	12 yrs 09 mon	11 yrs 05 mon 06 days
3	L.E. + Tro + Cap	16 yrs 09 mon 19 days	14 yrs 03 mon 19 days
4	C.E. to shaft	16 yrs 08 mon 14 days	14 yrs 02 mon
5	M.E. to shaft	16 yrs 08 mon 14 days	14 yrs 02 mon
6	Cap + L.E. to shaft	16 yrs 08 mon 14 days	11 yrs 04 mon 12 days
7	Cap + Tro to shaft	12 yrs 07 mon 15 days	11 yrs 05 mon 06 days

Table 3. Latest age of non-union of different epiphysis

Workers	Subjects	Trochlea fuses to Capitulum (in yrs)		L.E fuses to Capitulum (in yrs)		Trochlea + Capitulum + Lateral epicondyle (in yrs)		Conjoint epiphysis fuses to shaft (in yrs)		M.E. fuses to shaft (in yrs)	
	Indian	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**
Hepworth(1929)	Punjabis	-	-	14	15	-	-	14	15	14 1/2	14 1/2
Lall and Nat (1934)	Uttar Pradesh (Males)	-	-	-	-	-	-	-	15-17	-	15-17
Pillai (1936)	Madrasis	-	-	13-14	13-14	-	-	13-14	13-14	14-17	14-17
Basu and Basu (1938)	Bengalis (Females)	12-13	-	12-13	-	-	-	12-13	-	13-14	-
Galstaun (1939)	Bengalis	9-13	11-15	10-12	11-16	-	-	-	-	14	16
Lall and Townsend (1939)	Uttar Pradesh (Females)	-	-	-	-	-	-	-	-	14-15	-
Franklin (1962)	Vidarbha M.S. (Females)	13-14	-	13-14	-	-	-	13-14	-	14-15	-
Das Gupta et al (1971)	Uttar Pradesh	-	-	-	-	-	-	-	-	17-18	18-19
Kothari (1974)	Rajasthan	11-12	14-15	11-12	14-15	-	-	14-15	18	14	19-21
Jnanesh (2012)	Karnataka	12-13	15-16	12-13	15-16	-	-	12-13	16-17	14-15	18-19
	Other countries										
Davis and Parsons (1927)	Englanders	-	-	-	16	-	-	-	-	-	20
Patterson (1929)	England	14-15	14-15	14-15	17-18	-	-	14-15	18	14	19-21
Sidhom and Derry (1931)	Egypt	-	-	-	-	-	-	17	17	16-18	-
Flecker (1932)	Australians	-	13	13	13	-	-	-	-	15	16
Present study (2014)		**11-12**	**12-13**	**11-12**	**13-14**	**11-12**	**12-13**	**12-13**	**14-15**	**11-14**	**14-17**

Table 4. Comparative study of epiphyseal union of lower end of the humerus

In the age group of 17 – 18 years:

Among males in this age group, 100% of cases showed the union of the medial epicondyle with the shaft. Additionally, in all instances, the conjoint epiphysis and shaft were found to be united. Among females in this age group, 100% of cases showed complete union of the epiphysis of the medial epicondyle with the shaft. Also, the conjoint epiphysis showed complete union with the shaft in 100% of cases.

In the age group of 18 – 19 years:

Among males, the medial epicondyle and shaft were united in 100% of cases. Additionally, in all instances, the conjoint epiphysis and shaft were found to be united. Among females in this age group, 100% of cases showed complete union of the epiphysis of the medial epicondyle with the shaft. Also, the conjoint epiphysis showed complete union with the shaft in all (100%) of cases.

In the age group of 19 – 20 years:

Among females in this age group, 100% of cases showed the union of the medial epicondyle and conjoint epiphysis with the shaft. In this group, the union of the lower end of the epiphysis, including the epiphysis of the medial epicondyle and conjoint, showed complete union with the shaft in 100% of cases. The epiphyseal union at the lower end of the humerus is shown in table 1. The earliest age of union and the latest age of non-union of different epiphyses are shown in tables 2 & 3, respectively.

DISCUSSION

Appreciable variations in the moment of epiphysis union have been observed by the majority of researchers in this field. The comparative analysis between the results of the study of different workers and the present study are discussed below.

Fusion of trochlea with capitulum:

In the present study, the findings of females in the 11 – 12 years age group are similar to the study by Kothari (Rajasthan), but the fusion occurs 1 – 2 years earlier according to Galstaun (Bengalis) and 1 year later according to the study by Basu and Basu (Bengalis). It was also found to be late by 2 – 3 years in the studies conducted by Patterson (England) and Franklin (Vidarbha) [4-8].

Among males, the present statistical data is close to the studies by previous authors Galstaun, Flecker (Australians), but it is found to be 2 – 3 years earlier compared to the studies of Jnanesh (Karnataka), Kothari, and Patterson.[4, 5, 7, 9, 10].

Fusion of lateral epicondyle with capitulum:

In our study, the lateral epicondyle fuses with the capitulum among females at the age of 11 – 12 years, which is similar to the

findings of Galstaun (Bengalis) and Kothari (Rajasthan). But the studies conducted by Jnanesh (Karnataka) and Basu and Basu (Bengalis) were found to be 1 – 2 years later and also 2 – 3 years late in the studies by Pillai (Madrasis), Hepworth (Punjabis), Franklin (Vidarbha), and Patterson (England) [4-8,11,12]. In males, similar findings are seen by Pillai and Flecker, but the findings of Jnanesh, Hepworth, Kothari, and Patterson were found 1 – 2 years & 2 – 3 years later [4, 7, 9-12].

Fusion of conjoint epiphysis with shaft:

In the present study, fusions in females are similar to those seen in the studies by Jnanesh and Basu and Basu. They are 1 – 2 years later compared to the studies by Franklin and Pillai and 2 – 3 years late compared to the studies by Kothari and Patterson, and 4 years late compared to the studies of Sidhom and Derry (Egypt) [4, 6- 8, 11,13]. In males, it is 1 year late compared to studies by Pillai and 1 – 2 years later compared to studies by Jnanesh, Hepworth, Lall and Nat, Sidhom and Derry, but 3 – 4 years later compared to studies by Kothari and Patterson [4, 7, 10-14].

Fusion of medial epicondyle with shaft:

The present findings are similar to the studies by Basu and Basu, Galstaun, Kothari, and Patterson in females, and 6 months to 1 year later in the studies by Jnanesh, Hepworth, Lall and Townsend, Franklin, and Flecker. It was late by 2 – 3 years in the studies conducted by Das Gupta et al and Sidhom and Derry [4-10,13-16]

In the present study, the medial epicondyle fuses with the shaft in males around 14 – 17 years, which is closely related to the findings of Hepworth, Lall and Nat, Pillai, Galstaun, and Flecker. In some males, the fusion was found 1 – 4 years later compared to the studies conducted by Jnanesh, Das Gupta et al, Kothari, and Davis and Parsons [4,5,9-12, 14, 16, 17].

Taking into consideration the research work done by different workers on epiphyseal union at the lower end of the humerus, a table (Table 4) was drawn.

CONCLUSION

The following conclusions are made after studying the radiographs of 205 selected cases.

I. At the lower end of the humerus:

1. At the ages of 11–12 for females and 13–14 for males, the epiphyseal center of the lateral epicondyle fused with the capitulum.
2. The fusion of the trochlea and capitulum epiphyseal centers was observed in females at 11–12 years and in males at 12–13 years.
3. The fusion of the trochlea, capitulum, and epiphyseal center of the lateral epicondyle to form a compound epiphysis was observed in males at 12–13 years and in females at 11–12 years.

4. In females, the age of fusion of the conjoint epiphysis with the shaft was observed at 12–13 years, while in males, it was observed at 14–15 years.

5. In females, the epiphyseal center of the medial epicondyle fused with the shaft between the ages of 11 and 14 years, and in males between 14 and 17 years.

II. Fusion of epiphysis typically happens in females 1-3 years earlier than in males.

III. Diet had no effect on the fusion. Fig. 1 illustrates the progression of the union of conjoint epiphysis with the shaft in males and females with respect to age. Fig. 2 shows the progression of the union of the medial epicondyle with the shaft in males and females with respect to age.

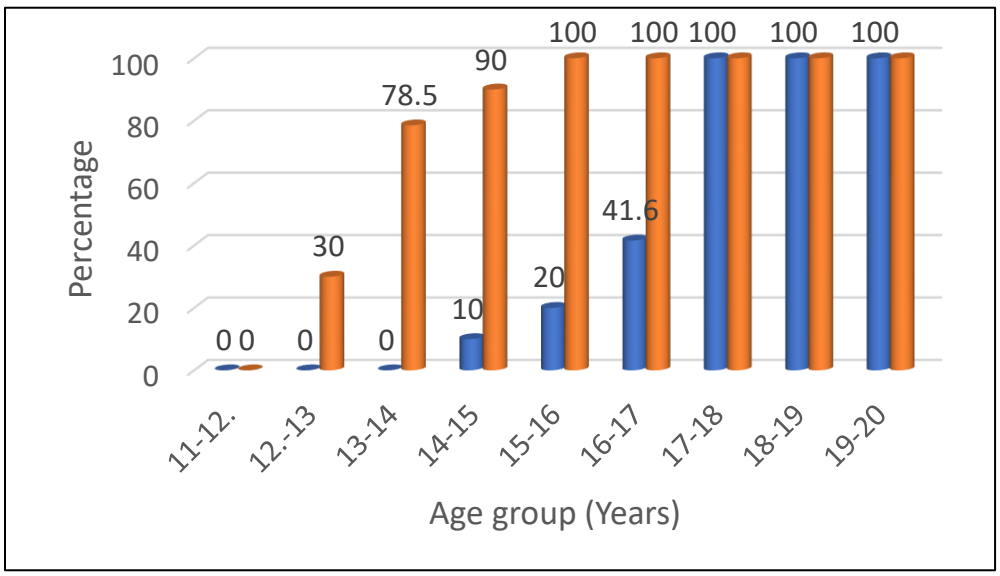

Fig. 1. Progress of union of C.E. With shaft in males and females in relation to age (data fitted in 3-D statistics graph)
Blue: C.E. males; Orange: C.E. females

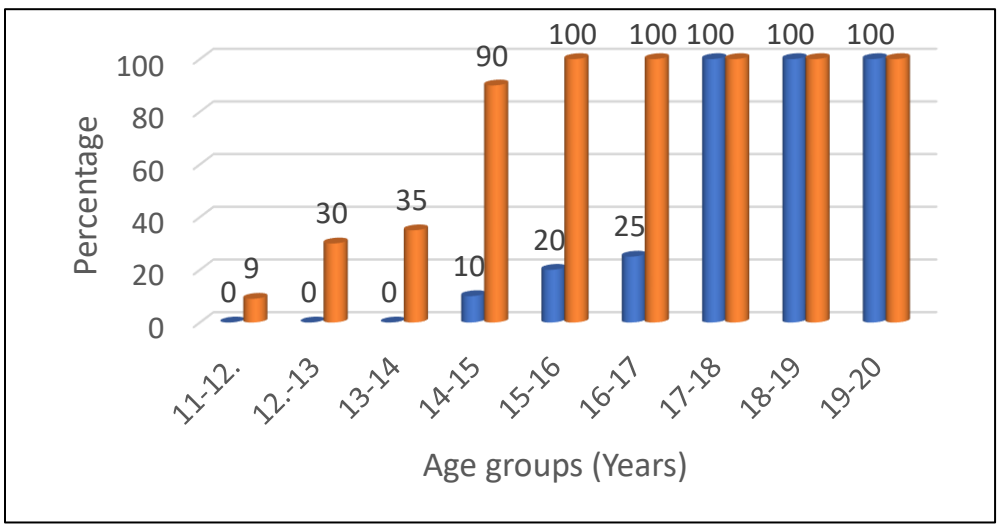

Fig. 2. Progress of union of E.E. with shaft in males and females in relation to age (data fitted in 3-D statistics graph)
Blue: M.E. males; Orange: M.E. females

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