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Estimation of Age from Shoulder Joint by Radiographic Assessment of Epiphyseal Fusion of Related Bones in Population of Chhattisgarh: A Cross Sectional Study

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Abstract

Age estimation of an individual is of medico legal importance in both civil & criminal cases. Ossification centres appear & fuse in a fairly definite sequence at a particular age group from which age of an individual can be determined. This study aims to investigate the relationship between the stage of epiphyseal union at shoulder joint & biological age in Chhattisgarh population. The study was carried out in 100 healthy subjects (40 girls and 60 boys) aging from 13 to 20 years. The obtained results from the radiographs revealed that the complete fusion of epiphysis of shoulder joint is seen at 18-20 years. Females were consistently developing epiphyseal union at a younger age than their male counterparts, with two years of difference. Results also suggest that the age of epiphyseal union is found to vary greatly all over the world indicating the need for separate standards of age of epiphyseal union for separate regions.

Keywords: *Epiphyseal Union, Shoulder Joint, Proximal End of Humerus.*

Introduction

In law, crime and punishment is entirely based on criminal responsibility and this in turn depends on the age of a person. Determination of age of an individual from epiphyseal union is a well accepted fact in the field of medical and legal professions. Epiphysis of the bone unites during age periods which are remarkably constant for a particular epiphysis. This is possible due to complex but dependable system by which the osseous framework of his body develops, grows & matures. Extensive work for the determination of age by epiphyseal union has been carried out in abroad and different states of India which revealed differences in the ages of epiphyseal union. The differences may be an account of varying dietetic, geographic, hereditary and other factors. Present study has been undertaken in indigenous population of Chhattisgarh from ossification around shoulder joints roentgenographically.

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Aims & Objectives

To evaluate age specific difference in epiphyseal union at shoulder joint.

1. To estimate age from epiphyseal union at shoulder joint.
2. To compare bisexual difference in epiphyseal union at shoulder joint.
3. To compare the findings in the epiphyseal union at shoulder joint in Central Indian population with other parts of India on the basis of previous studies.

Material & Method

The present study was carried out in the Department of Forensic Medicine & Department of Radiology, SSIMS, Bhilai, Chhattisgarh (Central India). A total of 120 individuals participated in this study. The subjects included were students of 13-20 years of age from schools & colleges from Bhilai city. They are born to parents living in Central India and have lived here since birth. The subjects do not have any disease/deformity

pertaining to bones or chronic disease affecting the general health. An informed consent was taken from all subjects prior to each investigation.

Procedure of Radiography: After taking written consent, thorough physical examination & radiological evaluation was done. X-Rays of right shoulder joint were taken with the help of X-Ray machine in the Department of Radiology. Minimum shots were taken to expose the joints involved in study. Minimum & appropriate voltage settings of X-Ray machine were applied so as to avoid unnecessary radiation exposure of the subjects. All the radiological procedure was undertaken according to the prescribed standards. Skeletal maturity was evaluated according to the Jits & Kulkarni's[7] classification of four stages: Appearance, Non fusion, Partial fusion & complete fusion ("A", "NF", "PF", "CF" respectively). The master chart was prepared and tabulated as per code given above. The data was examined and tallied by experts in Forensic Medicine and Radio-diagnosis. It was classified, analysed and compared with known standards. At the end conclusions were drawn, which were compared with available results of various previous studies.

Results

Fig 1.

Fig 2.

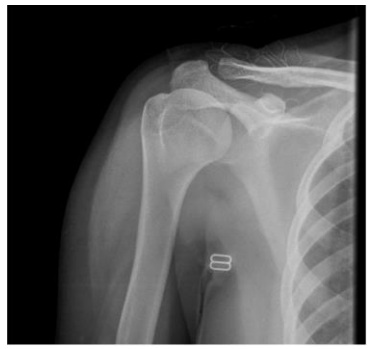

Fig 3.

(showing NF, PF & CF of proximal end of humerus respectively)

TABLE 1: Age & gender wise distribution of subjects.

Age in years	Males		Females	
	No	%	No	%
13-14	6	10	4	10
14-15	7	11.67	4	10
15-16	9	15	8	20
16-17	10	16.67	7	17.5
17-18	12	20	7	17.5
18-19	8	13.33	5	12.5
19-20	8	13.33	5	12.5
Total	**60**	**100**	**40**	100

Table 2: Epiphyseal fusion at proximal end of humerus:

Males				**Females**		
Age (years)	**NF**	**PF**	**CF**	**NF**	**PF**	**CF**
13-14	5 (8.33%)	1 (1.67%)	0 (0%)	2 (5%)	2 (5%)	0 (0%)
14-15	4 (6.67%)	3 (5%)	0 (0%)	0 (0%)	4 (10%)	0 (0%)
15-16	2 (3.33%)	6 (10%)	1 (1.67%)	0 (0%)	3 (7.5%)	5 (12.5%)
16-17	0 (0%)	6 (10%)	4 (6.67%)	0 (0%)	2 (5%)	5 (12.5%)
17-18	0 (0%)	2 (3.33%)	10 (16.67%)	0 (0%)	0 (0%)	7 (17.5%)
18-19	0 (0%)	0 (0%)	8 (13.33%)	0 (0%)	0 (0%)	5 (12.5%)
19-20	0 (0%)	0 (0%)	8 (13.33%)	0 (0%)	0 (0%)	5 (12.5%)
Total	**60 (100%)**			**40 (100%)**		

In males, proximal end of humerus shows: non fusion in 11 (18.33%) cases in age group of 13-16 years, partial fusion in 18 (30%) cases in age group of 13-18 years & complete fusion in 31 (51.67%) cases in age group of 15-20 years. Complete fusion is seen in all the subjects in age group of 18-20 years.

In females, distal end of humerus shows: non fusion in 2 (5%) cases in age group of 13-14 years, partial fusion in 11 (27.5%) cases in age group of 13-17 years & complete fusion in 27 (67.5%) cases in age group of 15-20 years. Complete fusion is seen in all the subjects in age group of 17-20 years.

Table 3: Epiphyseal fusion at acromion process:

Males				**Females**		
Age (years)	**NF**	**PF**	**CF**	**NF**	**PF**	**CF**
13-14	6 (10%)	0 (0%)	0 (0%)	4 (10%)	0 (0%)	0 (0%)
14-15	7 (11.67%)	0 (0%)	0 (0%)	2 (5%)	2 (5%)	0 (0%)
15-16	7 (11.67%)	2 (3.33%)	0 (0%)	1 (2.5%)	7 (17.5%)	0 (0%)
16-17	0 (0%)	8 (13.33%)	2 (3.33%)	0 (0%)	5 (12.5%)	2 (5%)
17-18	0 (0%)	9 (15%)	3 (5%)	0 (0%)	1 (2.5%)	6 (15%)
18-19	0 (0%)	2 (3.33%)	6 (10%)	0 (0%)	0 (0%)	5 (12.5%)
19-20	0 (0%)	0 (0%)	8 (13.33%)	0 (0%)	0 (0%)	5 (12.5%)
Total	**60 (100%)**			**40 (100%)**		

In males, acromion process shows: non fusion in 20 (33.34%) cases in age group of 13-16 years, partial fusion in 21 (35%) cases in age group of 15-19 years & complete fusion in 19 (31.66%) cases in age group of 16-20 years. Complete fusion is seen in all the subjects in age group of 19-20 years.

In females, acromion process shows: non fusion in 7 (17.5%) cases in age group of 13-16 years, partial fusion in 15 (40.5%) cases in age group of 14-18 years & complete fusion in 18 (45%) cases in age group of 16-20 years. Complete fusion is seen in all the subjects in age group of 18-20 years.

Table 4: Fusion of Coracoid Process:

	Males			Females		
Age (years)	**NF**	**PF**	**CF**	**NF**	**PF**	**CF**
13-14	4 (6.66%)	2 (3.33%)	0 (0%)	2 (5%)	2 (5%)	0 (0%)
14-15	4 (6.66%)	3 (5%)	0 (0%)	0 (0%)	4 (10%)	0 (0%)
15-16	2 (3.33%)	7 (11.67%)	0 (0%)	0 (0%)	2 (5%)	6 (15%)
16-17	0 (0%)	2 (3.33%)	8 (13.33%)	0 (0%)	0 (0%)	7 (17.5%)
17-18	0 (0%)	0 (0%)	12 (20%)	0 (0%)	0 (0%)	7 (17.5%)
18-19	0 (0%)	0 (0%)	8 (13.33%)	0 (0%)	0 (0%)	5 (12.5%)
19-20	0 (0%)	0 (0%)	8 (13.33%)	0 (0%)	0 (0%)	5 (12.5%)
Total	**60 (100%)**			**40 (100%)**		

In males, coracoid process shows: non fusion in 10 (16.65%) cases in age group of 13-16 years, partial fusion in 14 (23.33%) cases in age group of 13-17 years & complete fusion in 36 (60%) cases in age group of 16-20 years. Complete fusion is seen in all the subjects in age group of 17-20 years.

In females, coracoid process shows: non fusion in 2 (5%) cases in age group of 13-14 years, partial fusion in 8 (20%) cases in age group of 13-16 years & complete fusion in 30 (75%) cases in age group of 16-20 years. Complete fusion is seen in all the subjects in age group of 16-20 years.

Discussion

Table 5: Comparison of average ages of fusion of epiphyses around shoulder joint in males and females:

Sr. No	Researcher	Humerus (years)	Acromion (years)	Coracoid (years)
1.	Davies & Parson (1927)[1]	19-21	-	-
2.	Flecker (1932)[2]	17-19	17	18-20
3.	Pillai (1936)[3]	17	18	14
4.	Galstaun (1937)[4]	17-19	17-19	-
5.	Cardoso Hugo (2008)[5]	20-23	19-20	17-18
6.	Buri S et al (2017)[6]	18-19	19-20	16-17
7.	**Present study**	**17-19**	**18-20**	**16-18**

Proximal end of humerus: The observations of present study matches with works of Flecker (1932)[2] in Australian population, Pillai (1936)[3] in South Indian population & Galstaun (1937)[4] in Indian population. Studies conducted by Davies & Parson (1927)[1] in English population, Cardoso Hugo (2008)[5] in Portugese population & Buri S et al (2017)[6] in Rajasthani population show comparatively late fusion of epiphysis by 1-3 years.

Acromion: The observations of present study matches with work of Pillai (1936)[3] in South Indian population. Studies conducted by Galstaun (1937)[4] in Indian population, Cardoso Hugo (2008)[5] in Portugese population & Buri S et al (2017)[6] in Rajasthani population show comparatively late fusion of epiphysis by 1-2 years.

Coracoid: The observations of present study matches with works of Buri S et al (2017)[6] in Rajasthani population. Studies conducted by Flecker (1932)[2] in Australian population & Cardoso Hugo (2008)[5] in Portugese population show late fusion by 1-2 years whereas there is early fusion at 14 years in study conducted by Pillai (1936)[3] in South Indian population.

Summary and Conclusions

1. This study was conducted exclusively on the young indigenous population of Chhattisgarh region.
2. The epiphyseal union of bones at right shoulder joint in males is completed in all instances (100%) at the age of 19-20 years.
3. The epiphyseal union of bones at right shoulder joint in females is completed in all instances (100%) at the age of 18-20 years.
4. As the sample size is limited further studies are necessary. Region wise studies should be conducted for better correlation and comparison.
5. Due to changing lifestyle pattern, dietary, climatic, behavioural factors age of ossification is changing as mentioned in the available literature. So as to evaluate these changes, studies are recommended in every region of India at regular time period for academic and judicial interest.
6. The opinion about age should be given always in the range. From this study it can be concluded that the opinion about age can be given in a range having margin of error of 1-2 years.
7. Radiological interpretations are observer dependent so the set standards should be considered under expert guidance to arrive at conclusion in such radiological studies.
8. For estimation of age relevant joints should be radiologically examined for different centres and opinion should be arrived considering the status of multiple centres.

Ethical Clearance- Taken from institutional ethical committee.

Source of Funding- Self.

Conflict of Interest- Nil.

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