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Original Research Article

A Retrospective Study Assessing Age Based on Digital X-Ray Images of the Shoulder Joint

Pappu Kumar[1], Dhrubo Midya[2], Biswajit Sukul[3]

[1]Assistant professor, Department of FMT, Gouri Devi Institute of Medical Science and Hospital, Durgapur, West Bengal, India

[2]Senior Resident, Department of FMT, Narayan Medical College and Hospital, Jamuhar, Sasaram, Bihar, India

[3]Professor and HOD, Department of FMT, Gouri Devi Institute of Medical Science and Hospital, Durgapur, West Bengal, India

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Corresponding Author: Dr. Dhrubo Midya
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Abstract

Aim: To investigate the process of estimating age based on digital X-ray images of the shoulder joint.

Material and Methods: The present study was conducted was conducted in Department of FMT, Gouri Devi Institute of Medical Science and Hospital, Durgapur, West Bengal, India for one year. This study was carried out on total 200 subjects between the age group of 14 years to 20 years. Written and informed consent for X-ray were taken from all subjects. Performa and Information sheet used in English and Hindi language. Information of address, education, disease, any habit, age, sex, physical development, nutritional status, work, handedness, diet, family size, socio-economic condition was taken from the subjects. Documentary proof of birth certificate, school leaving certificate, Ration card, election ID, Aadhar card, school ID, hospital record and Driving license verified. Subject for age estimation, MLC and cases referred by CMO from Casualty.

Results: This study was conducted at Department of forensic medicine. This study was carried out on 200 participants who belong to the age group of 14-20 years attending the Forensic Medicine. Thus in our study, of the total 200 participants, 100, i.e. 50% were males and 100, i.e. 50% were females. In the present study total numbers of female candidates are 15 and 66.6 percentage of candidates which show complete fusion; in age groups of 17 to 18 years and total numbers of male candidates are 7 and 85.71 percentage of candidates which completed (i.e. stage 3) fusion in age groups of 18 to 19 years according to their respective diets. As is evident from the above tables, no significant effect of the diet of an individual is seen on the fusion of Head of Humerus As is evident from the tables, no significant effect of the Socio-Economic class is seen on the fusion of Head of humerus with respective age in both males and females.

Conclusions: In females, the ossification center of shoulder joint occurs earlier than males by one year as seen above. The complete fusion of centers of shoulder joint occurs one to two years later in the population of Bihar than south Indian population and most of the remaining parts of India, centers of shoulder joint fuse at approximately the same as other parts of INDIA. There is no association of vegetarian and non-vegetarian diet on the fusion of epiphyseal centers, in both male and females.

Keywords: Age, Digital X-ray, Shoulder joint

Introduction

Age estimation is a crucial aspect of forensic science, particularly in the identification of unknown individuals in both legal and anthropological contexts. Traditional methods of age estimation often rely on the analysis of skeletal remains, with particular attention given to the morphology and development of specific bones. The shoulder joint, comprising the clavicle, scapula, and humerus, offers several anatomical landmarks that are valuable in age determination. Recent advancements in digital radiography have enhanced the precision and reliability of these methods, allowing for more accurate age estimation based on the examination of shoulder joint X-rays. Digital X-rays provide a non-invasive, efficient, and reproducible means of assessing skeletal development and degeneration, which are key indicators of age. [1-3] Unlike traditional radiographic techniques, digital radiography allows for enhanced image manipulation, precise

measurements, and easier storage and retrieval of images. This technology has been particularly useful in forensic anthropology, where the estimation of age from skeletal remains is a common requirement. The clavicle, also known as the collarbone, is one of the last bones in the human body to complete its ossification process, making it an excellent indicator of age in late adolescence and early adulthood. The medial clavicular epiphysis, in particular, undergoes a well-documented sequence of ossification stages that can be observed and measured using digital X-rays. Studies have demonstrated that the fusion of the clavicular epiphysis can provide a reliable estimate of age, typically completing between the ages of 21 and 25 years . Similarly, the humerus, the long bone of the upper arm, exhibits distinct developmental stages that can be used for age estimation. The epiphyseal fusion of the proximal humerus follows a predictable pattern, which can be visualized through digital radiography. [4-6] This method has been shown to be particularly effective in estimating age in younger individuals, where the degree of epiphyseal fusion corresponds closely with chronological age . The scapula, or shoulder blade, also offers several ossification centers that can be evaluated for age estimation. The fusion of these centers follows a relatively consistent timeline, and digital X-ray imaging allows for the detailed examination of these features. Research has shown that the scapula's ossification process can provide supplementary information to enhance the accuracy of age estimation derived from other bones in the shoulder joint . The application of digital X-ray technology in age estimation has several advantages over traditional radiographic methods. Digital images can be easily enhanced to improve clarity and detail, allowing for more precise identification of ossification stages and degenerative changes. Additionally, digital X-rays facilitate the application of advanced image analysis software, which can assist in the automatic detection and measurement of relevant anatomical features, reducing the potential for human error and increasing the consistency of age estimations . [7]

Material and Methods

The present study was conducted was conducted in Department of FMT, Gouri Devi Institute of Medical Science and Hospital, Durgapur, West Bengal, India for one year. This study was carried out on total 200 subjects between the age group of 14 years to 20 years. Written and informed consent for X-ray were taken from all subjects.

Inclusion Criteria

Subject for age estimation, MLC and cases referred by CMO from Casualty. Date of birth proof for age. Age group between 14 years to 20 years. Persons free from any physical disability. No any bone and cartilage disease and fracture of shoulder joint. Persons willing to join this study.

Exclusion Criteria

Pregnancy. Persons suffering from previous or current H/O bone and cartilage disease and fracture of Shoulder joint. Persons who have previous or current H/O any disease, physical disability.

Methodology

The X- ray AP view of Shoulder joint taken by using digital X-ray method for appearance and fusion of ossification centers of acromion process, coracoids process and head of humerus. The X- ray of the Shoulder joint were taken in antero-posterior (AP) view using a factor 55 KVP and 9 MAS. Care was taken for the centering of X-ray tube over the epiphyses as it is quite easy to give un-united epiphyses the appearance of union by directing the cone of rays obliquely.

Adequate precautions were taken to avoid unnecessary X- ray exposure of subjects by providing them lead gown.

Radiological Findings: Skeletal maturity was evaluated according to the Jits and Kulkarni's classification of four stages, Appearance, non-fusion, Partial fusion, complete fusion.[4] Stage 0: When the epiphyseal cartilage did not begin to decrease in thickness designated as "Not appeared".

Stage 1: X-ray showing clear gap between the epiphyseal and diaphyseal, showing saw tooth like appearance end were designated as "Non fusion".

Stage 2: X-ray showing a line replacing the hiatus between the epiphyseal and diaphyseal end and not showing saw tooth like appearance were designated as "Partial fusion".

Stage 3: X-ray showing the same bony architecture in the diaphysis and epiphysis and showing scar of the previous stage were designated as "Complete fusion".

Results

This study was conducted at Department of forensic medicine. This study was carried out on 200 participants who belong to the age group of 14-20 years attending the Forensic Medicine.

Thus in our study, of the total 200 participants, 100, i.e. 50% were males and 100, i.e. 50% were females. As evident from the table, in our study, we have found that in statistically significant number cases, the age of fusion of head of humerus in male 18 – 19 years and 17 – 18 years in females, which is in accordance with the findings of Reddy K S N (Andhra Pradesh 1973) [5], Saini O P (Jaipur - 2005) [6] , Agarwal Anil (Delhi - 2006)[1], Pimple D H (Mumbai - 2013) [7], Tirpude B.H (Maharashtra-2014) [8] but not with Galstaun (Bengal – 1937) [9],

his study suggest that fusion occurs at lower age. Davies and Parson (England - 1927) [3], study suggest that fusion occurs at 20 years in male and 18 years in female and Flecker (Melbourne - 1932) [10] study suggest that fusion occurs at 19 years in male and 17 years in female.

Diet and Fusion of Head of Humerus: In the present study total numbers of female candidates are 15 and 66.6 percentage of candidates which show complete fusion; in age groups of 17 to 18 years and total numbers of male candidates are 7 and 85.71 percentage of candidates which completed (i.e. stage 3) fusion in age groups of 18 to 19 years according to their respective diets. As is evident from the above tables, no significant effect of the diet of an individual is seen on the fusion of Head of Humerus As is evident from the tables, no significant effect of the Socio-Economic class is seen on the fusion of Head of humerus with respective age in both males and females.

Table 1: Comparison of ossification of proximal end of humerus with Age, Sex and other studies

	Age of ossification of proximal end of humerus in years	
Study	Male	Female
Indian studies		
Hepworth (Punjabi-1929)		17-18
Pillai (Madras – 1936)		14-17
Galstaun (Bengal – 1937)	14-18	14-16
Reddy KSN (Andhra Pradesh - 1973)	18-19	17-18
Sahana S N(Bengal - 1986)	-	18
Saini O P (Jaipur - 2005)	18-19	17-18
Agarwal Anil (Delhi - 2006)	18	17
Pimple D H (Mumbai - 2013)	18-19	17-18
Tirpude B H (Maharashtra - 2014)	-	17-18
Present Study	18-19	17-18
Foreign studies		
Paterson (Manchester - 1926)	20	18
Davies and Parson (England -1927)		19-21
Flecker (Melbourne - 1932)	19	17
Krogman (USA-1960)	-	18-19
Knight B (UK - 1961)	16-23	-
Cardoso Hugo (Spain - 2008)	-	20
Memon *et al.* (Pakistan - 2008)	-	16-17

Table 2: SE Class and fusion of head of humerus

Age groups		**Socio-economic status**								
		5 and 4			**3 and 2**			**1**		
	Sex	**No**	**total**	**%**	**No**	**total**	**%**	**No**	**total**	**%**
14-15 Years	Male	0	3	0	0	11	0	0	0	0
	Female	0	4	0	0	11	0	0	0	0
15-16 Years	Male	0	5	0	0	8	0	0	2	0
	Female	0	1	0	0	9	0	0	0	0
16-17 Years	Male	0	6	0	0	5	0	0	0	0
	Female	0	7	0	0	7	0	0	0	0
17-18 Years	Male	1	7	14.29	1	9	11.11	0	0	0
	Female	3	4	75	6	11	54.55	3	4	75
18-19 Years	Male	5	6	83.33	6	6	100	2	2	100
	Female	6	6	100	8	9	88.89	0	0	0
19-20 Years	Male	5	5	100	9	9	100	0	0	0
	Female	5	5	100	7	7	100	1	1	100
20-21 Years	Male	5	5	100	11	11	100	0	0	0
	Female	7	7	100	7	7	100	0	0	0
Total	Male	16	37		27	59		2	4	
	Female	21	34		28	61		4	5	

Discussion

The digital X-ray of shoulder joint A P view and to study fusion of head of humerus of shoulder joint in males and females were done. The process of fusion was sub divided in to various stages and study was done to find out its relation to various factors like sex, diet, religion, socioeconomic class were observed:

As far as the relation of sex with fusion of centers of shoulder joint concerned, the findings of my study are very much in accordance with the findings of all other studies, both foreign and Indian studies that we have come across i.e. fusion of these centers occurs earlier in females by one to two years as compared to males. [11,12,13]

Except for us, Kalpesh Shah (1991) and Jain S. [14,15], no other researcher has studied the relation of vegetarian or non-vegetarian diet with fusion of epiphyseal centers and as far as we know, all the three studies agree that there is no association of vegetarian and non- vegetarian diet on the fusion of epiphyseal centers, in both male and females.[16]

Socio-Economic Class and Fusion of Shoulder Joint this relation was studied to testify the hypothesis that higher SE class leads to better nourishment and better overall growth and thus to earlier / later fusion of epiphysis. However, no significant effect of the Socio- Economic Class of an individual was seen on the fusion of centers of shoulder joint in either males or females, neither in our study, nor in any other study. [7,13,14]

Conclusions

In the present study from the observations, the following conclusions were drawn: A of complete fusion of Head of Humerus in Males 18-19 years and in Females 17-18 years. In females, the ossification center of shoulder joint occurs earlier than males by one year as seen above. The complete fusion of centers of shoulder joint occurs one to two years later in the population of Bihar than south Indian population and most of the remaining parts of India, centers of shoulder joint fuse at approximately the same as other parts of INDIA. There is no association of vegetarian and non-vegetarian diet on the fusion of epiphyseal centers, in both male and females. There is no significant effect of the Socio-Economic Class of an individual was seen on the fusion of centers of shoulder joint in either males or females, neither in our study, nor in any other study.

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