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Original Research Article

A Cross Sectional Study of Age Estimation from Appearance and Fusion of Acromion Process of Scapula in Shoulder Joint by Digital X-ray

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Forensic Science, Forensic Anthropology, Sexual Dimorphism, Deltoid Tuberosity, Mass Disaster, Discriminant Function Analysis.

Abstract

Introduction: Age estimation is one of the most important thing in court of law and in civil cases. The experts have to look for age in different medico legal cases. **Material & Methods:** The present cross sectional study was conducted in the Department of Forensic Medicine and Toxicology at Tertiary Care Medical Institution. This study was carried out on total 200 subjects between the age group of 14 years to 20 years. The X- ray AP view of Shoulder joint taken by using digital X-ray method for appearance and fusion of ossification centres of acromion process, coracoids process and head of humerus. Evaluation of skeletal maturity was done abiding to the Jits and Kulkarni's classification of four stages viz. Appearance, Non fusion, Partial fusion and complete fusion. The appearance and fusion was studied according to the age, gender and diet of the participants. **Results:** Out of 200 subjects, 100 were males and rest 100 were females. We had 35 cases from age group of 17-18 years (17.5%). Appearance of acromion process present in 93.33% of the females were in the age group of 14 – 15 years and 80% of the males were in the age group of 15 – 16 years, fusion of acromion process doesn't begin below 15 years of age. We observed that there is no association of vegetarian and non-vegetarian diet on the fusion of epiphyseal centres, in both male and females. **Conclusion:** We observed that the complete fusion of Acromion process in Males 18-19 years and in Females a year earlier during 17-18 years. The complete fusion of centres of Acromion process occurs one to two years later than the subject of South India, England and America.

1. Introduction

Forensic medicine experts especially in the developing countries like India where the birth records are many a times not properly maintained; and even if these are maintained, there have been some incidences of forgery.[1-2] The experts have to evaluate the age in different medico legal cases. However this data to some extent is influenced by various subjects' parameters. These parameters are heredity and genetic makeup, race, and various environmental factors.[3]

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These environmental factors are climate, diet, disease process, Geographical conditions etc. but still its scientific confirmation is required by court of law and certain administrative departments.[4,5] Considering these variations, we have tried to give the status of appearance and fusion of Acromion process of Scapula which would be helpful for age determination of subjects between 14-21 years' age group in south Gujarat region.

2. Aim and Objectives

- To estimate the appearance and ossification of Acromion process in study subjects
- To estimate appearance and ossification of Acromion process in relation to age, sex, diet, & Geographical condition in the age group between 14 years to 20 years in living human beings.
- To find the relationship between diet and appearance and ossification of Acromion process in the shoulder region.

3. Material & Methods

This study was carried out in the Department of Forensic Medicine and Toxicology at GMC and New Civil Hospital, Surat, Gujrat. This cross-sectional study was carried out on total 200 participants between the age group of 14 years to 21 years.

1. Ethical committee approval was obtained before the start of study.
2. Permission from the Radiology department of New civil Hospital, Surat for Digital X- ray was taken.
3. Written and informed consent was taken from all subjects.
4. Information of age, sex, address, education, any habit, physical development, nutritional status, work, handedness, diet, family size, socio-economic condition and history of any disease or accidents was taken from the subjects.
5. Documentary proof of age by birth certificate, Ration card, election ID, Aadhar card, school ID, school leaving certificate, hospital records and Driving licence were verified.

Sampling method: Simple random sampling.

Inclusion criteria:

1. Subject from South Gujarat Region coming to Forensic Medicine Department for age estimation, MLC and cases referred by CMO from Casualty.
2. Date of birth proof for age.
3. Age group between 14 years to 20 years and both genders.
4. Persons willing to join this study.

Exclusion criteria:

1. Pregnant females.
2. Persons suffering from previous or current H/O bone and cartilage disease and fracture of Shoulder joint.
3. Persons who have previous or current H/O any disease, physical disability.
4. Subject from out of South Gujarat Region.

Methodology:

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

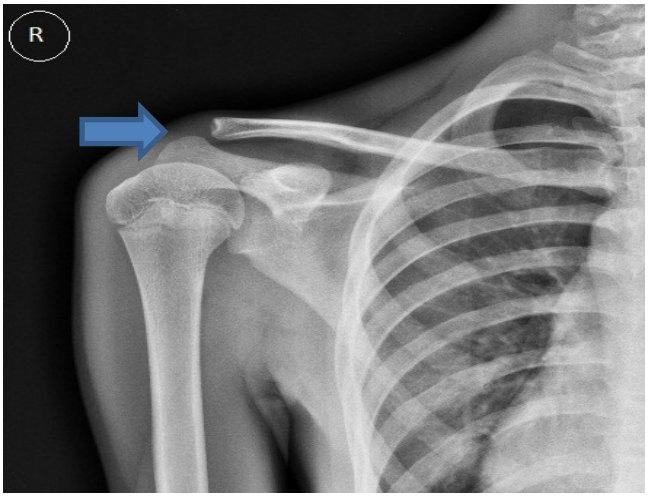
Appropriate precautions were taken to avoid the unnecessary exposure of participants by providing them the lead gown, and the procedure of X ray was carried out in department of Radiology, New Civil Hospital and Government Medical College, Surat, Gujarat.

Radiological Findings:

Skeletal maturity was evaluated according to the Jits and Kulkarni's classification of four stages viz. Appearance, non-fusion, Partial fusion, complete fusion.

- **Stage 0:** When the epiphyseal cartilage has not begun to decrease in thickness designated as "Not appeared".

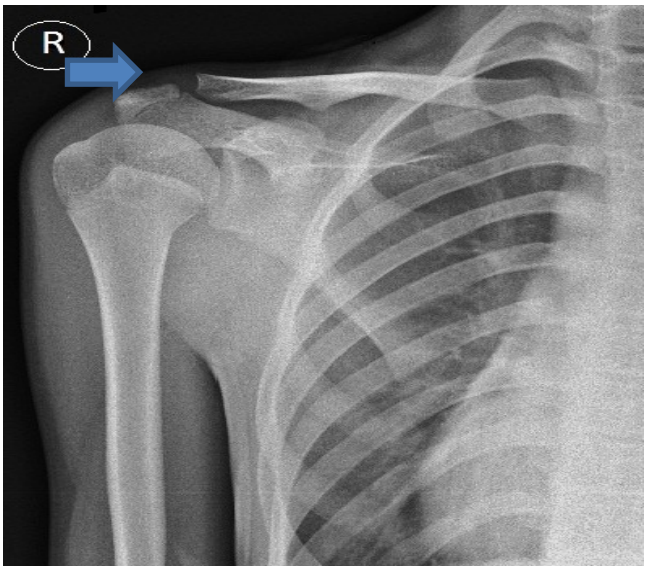
Digital Radiograph No. 1: X-ray showing stage 0: Acromion process not appeared (X- Ray I D No- 5515/15).



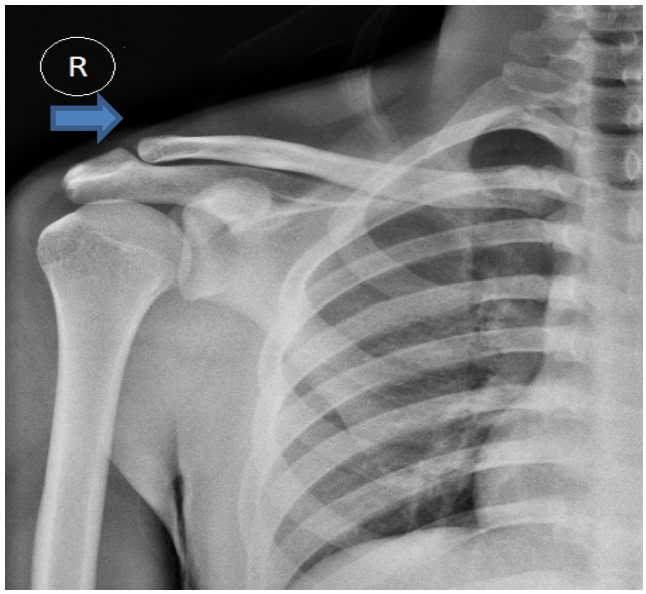
- **Stage 1:** X-ray showing clear gap between the epiphyseal and diaphyseal, showing saw tooth like appearance end were designated as "Non fusion".

- **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".

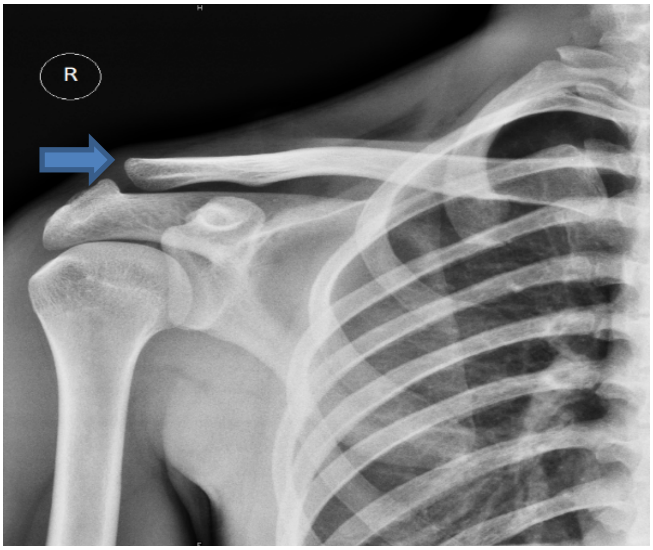
Digital Radiograph No. 2: X-ray showing stage 1: Acromion process of scapula non fusion (X- Ray I D No-45913/15).



Digital Radiograph No. 3: X-ray showing stage 2: Acromion process partial fusion (X- Ray I D No-30322/15).



Digital Radiograph No. 4: X-ray showing stage 3: Acromion process complete fusion (X- Ray I D No-62883/15).



4. Results:

This study was carried out on 200 subjects who belonged to the age group of 14-21 years attending the Forensic Medicine and Toxicology Department and outpatient department of New Civil Hospital, Surat. We observed that in our study, of the total 200 participants, 100, i.e., 50% were males and rest 100, i.e., 50% were females (**Table no. 1**).

Table 1: Age and Sex distribution of participants

Age groups	Male	Female	Total
14-15 yrs.	14 (7%)	15 (7.5%)	29 (14.50%)
15-16 yrs.	15 (7.50%)	10 (5.00%)	25 (12.50%)
16-17 yrs.	11 (5.50%)	14 (7.00%)	25 (12.50%)
17-18 yrs.	16 (8.00%)	19 (9.50%)	35 (17.50%)
18-19 yrs.	14 (7.00%)	15 (7.50%)	29 (14.50%)
19-20 yrs.	14 (7.00%)	13 (6.50%)	27 (13.50%)
20-21 yrs.	16 (8.00%)	14 (7.00%)	30 (15.00%)
TOTAL	100 (50.00%)	100 (50.00%)	200 (100%)

We had 35 cases from age group of 17-18 years (17.5%), 30 cases from 20-21 years (15%), 29 cases from 18-19 years (14.5%), 27 cases from 19-20 years (13.5%) and 25 cases each from 15-16 and 16-17 years (12.5%).

Fusion of acromion process findings with age and sex tabulated in **table no. 2**. As is evident from this table, appearance of acromion process present in 93.33% of the females in the age group of 14 – 15 years and 80% of the males in the age group of 15 – 16 years,

fusion of acromion process doesn't begin below 15 years of age and number of candidates showing greater stage of ossification increased with increasing age and stage 3 of fusion was latest seen in 27.27 % of male and 85.71% in cases of female in the age group of 16 year -17years, 62.5% of male and 100% of female cases in the age group of 17 - 18 years, 100 % of male and 100% of the females in the age group of 18 - 19 years, 19 - 20 years and 20 – 21 years.

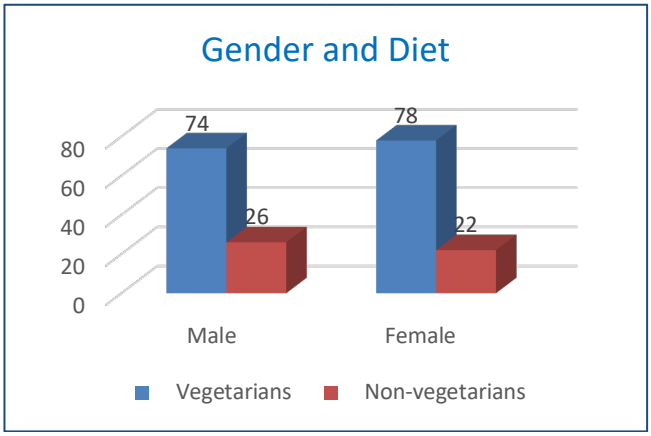
As is evident from the table appearance of acromion process present in 93.33% of the females in the age group of 14 – 15 years and 80% of the males in the age group of 15 – 16 years, fusion of acromion process doesn't begin below 15 years of age and number of candidates showing greater stage of ossification increased with increasing age and stage 3 of fusion was latest seen in 27.27 % of male and 85.71% in cases of female in the age group of 16 year -17years, 62.5% of male and 100% of female cases in the age group of 17 - 18 years, 100 % of male and 100% of the females in the age group of 18 - 19 years, 19 - 20 years and 20 – 21 years.

Vegetarians were more in our study, 74 males (37%) and 78 females (39%) were vegetarians while 26 males (13%) and 22 females (11%) were non-vegetarians (**Figure no. 1**).

Table 2: Age, gender and fusion of acromion process.

Age Group	Appearance and Fusion of acromion process					Total
	Sex	Stage 0	Stage 1	Stage 2	Stage 3	
14-15 yrs.	Male	11 (78.57%)	3 (21.43%)	0 (0%)	0 (0%)	14 (100%)
	Female	1 (6.67%)	14 (93.33%)	0 (0%)	0 (0%)	15 (100%)
15-16 yrs.	Male	0 (0%)	12 (80%)	3 (20%)	0 (0%)	15 (100%)
	Female	0 (0%)	4 (40%)	6 (60%)	0 (0%)	10 (100%)
16-17 yrs.	Male	0 (0%)	0 (0%)	8 (72.73%)	3 (27.27%)	11 (100%)
	Female	0 (0%)	0 (0%)	2 (14.29%)	12 (85.71%)	14 (100%)
17-18 yrs.	Male	0 (0%)	0 (0%)	6 (37.5%)	10 (62.5)	16 (100%)
	Female	0 (0%)	0 (0%)	0 (0%)	19 (100%)	19 (100%)
18-19 yrs.	Male	0 (0%)	0 (0%)	0 (0%)	14 (100%)	14 (100%)
	Female	0 (0%)	0 (0%)	0 (0%)	15 (100%)	15 (100%)
19-20 yrs.	Male	0 (0%)	0 (0%)	0 (0%)	14 (100%)	14 (100%)
	Female	0 (0%)	0 (0%)	0 (0%)	13 (100%)	13 (100%)
20-21 yrs.	Male	0 (0%)	0 (0%0)	0 (0%)	16 (100%)	16 (100%)
	Female	0 (0%)	0 (0%)	0 (0%)	14 (100%)	14 (100%)
Total	Male	11 (11%)	15 (15%)	17 (17%)	57 (57%)	100 (100%)
	Female	1 (1%)	18 (18%)	8 (8%)	73 (73%)	100 (100%)

Fig 1: Gender and Diet of the participants



5. Discussion:

The digital X-ray of shoulder joint A P view is taken in Radiology Department of New civil hospitals, Surat and to study appearance and fusion of acromion process 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.

Age and appearance of acromion process of shoulder joint:

As evident from the **table no. 3**, in our study, we have found that in statistically significant number cases age appearance of acromion process 15 – 16 years in males and 14 – 15 years in females which is in accordance with findings of Reddy KSN (Andhra Pradesh - 1973)[6], Flecker (Melbourne - 1932)[7] and this finding one year higher in male and two years in female than Galstaun (Bengal-1937)[8].

Table 3: Comparison of appearance of acromion process of scapula with other studies.

Sr. No	Study	Age of appearance of acromion process of scapula in years	
		Male	Female
Indian studies			
1	Pillai (Madras – 1963)[9]	13- 14	
2	Galstaun (Bengal – 1937)[8]	14-17	12-14
3	Reddy KSN (Andhra Pradesh -1973)[6]	15	14
4	**Present Study (South Gujarat 2015)**	**15-16**	**14-15**
Foreign Studies			
1	Flecker (Melbourne - 1932)[7]	15	14

Age and fusion of centers of shoulder joint:

Pillai (Madras-1963)[9] observed fusion at age of 18 years. As we observed in our study from the **table no. 4**, we have found that in statistically significant number cases, the age of fusion of acromion process in male 17 – 18 years and 16 – 17 years in females, which is in accordance with the findings of Reddy K S N (Andhra Pradesh 1973)[6], Saini O P (Jaipur - 2005)[10], Pimple D H (Mumbai - 2013)[11] but not with Galstaun (Bengal – 1937)[8], his study suggest that fusion occurs at lower age. Betala A P (Bagalkot – 2014)[12] observed fusion above age of 16 years in male and Knight B (UK-1961)[13] observed fusion at age of 17-91 years in male.

Table 4: Comparison of fusion of acromion process of scapula with other studies

Sr. No	Study	Age of ossification of acromion process of scapula in years	
		Male	Female
Indian studies			
1	Pillai (Madras – 1963)[9]	18	
2	Galstaun (Bengal – 1937)[8]	14-19	13-16
3	Reddy KSN (Andhra Pradesh -1973)[6]	17-18	16-17
4	Saini O P (Jaipur - 2005)[10]	17-18	16-17
5	Pimple D H (Mumbai - 2013)[11]	17-18	15-16
6	Betala A P (Bagalkot – 2014)[12]	Above 16	-
7	**Present Study (South Gujarat 2015)**	**17-18**	**16-17**
Foreign Studies			
1	Flecker (Melbourne - 1932)[7]	17	17
2	Knight B (UK-1961)[13]	17-19	-

Sex and fusion of centers of shoulder joint:

The relation of sex with ossification of the centres of shoulder joint concerned, the findings of our study are in accordance with the findings of all other studies, both foreign and Indian studies that we have come across, i.e. fusion of these centres occurs earlier in females by 1-2 years as compared to males.[14-15]

Diet and fusion of centers of shoulder joint:

Except for us, Kalpesh Shah (Gujarat 1991).[14] and Yadav D[15], no other researcher has studied the relation of vegetarian or non-vegetarian diet with fusion of epiphyseal centres 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 centres, in both male and females.

6. Summary and Conclusions:

- In the present study from the observations, the following conclusions were drawn:

- A of complete fusion of Acromion process in Males 18-19 years and in Females 17-18 years.
- In females, the ossification centre of Acromion process occurs earlier than males by one year as seen above.
- The complete fusion of centres of Acromion process occurs one to two years later than the subject of England and America.
- The complete fusion of centres of Acromion process occurs one to two years later in the population of south-Gujarat than south Indian population and most of the remaining parts of India, centres 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 centres, in both male and females.

Conflict of interest: None.
Ethical Clearance: Yes.
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