



To assess the skeletal maturity at medial end of clavicle for known chronological age in subjects of Jodhpur region of Rajasthan

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Abstract

Background: *The estimation of the age of persons who are assumed to be older than 18 years, it is particularly important to evaluate the progress of ossification of the epiphysis at medial end of clavicle, because all other developmental systems under examination have completed their growth by this time. The present study has been undertaken to study roentgen graphically the epiphyseal appearance and fusion of medial end of clavicle in subjects between age group of 20 to 25 years.*

Material & Methods: *A community based cross sectional study done on randomly selected subjects of both sexes having age between 20 to 25 years of age amongst the visiting to MLC –OPD in Mahatma Gandhi Hospital /Mathuradas Mathur Hospital Jodhpur who will fulfill the selection criteria, after proper history taken in relation to age estimation, availability of certificate indicating the age of birth or any such relevant document and physical examination.*

Results: *In present study, majority of cases show complete union at 22 years for both males and females. There is no variation in mean ages when sex comparison were made for the age of complete fusion.*

Conclusion: *We concluded from the present study that the complete epiphyseal union at medial end of clavicle in population of Jodhpur region occurred at the age of 22 years, in both males and females.*

Keywords: *Medial end of clavicle, Fusion, Epiphysis, Estimation of age.*

Introduction

Age estimation is a common feature and problem of Forensic practice all over the world. In a country like ours it is more so, since illiteracy is a common feature and awareness for birth registration is too less. Scientific determination of age of an individual is a necessity for the law enforcement agencies in both civil and criminal matters. Various processes and methods of age estimation have been evolved through decades. As a matter of fact, ageing of the human being starts

right from the moment of conception. During the span of life, various features of development and growth occur in chronological order. A systematic study of ossification of bones is helpful in assessing the age. The establishment or confirmation of personal identity is primarily the job of investigating agency but these investigating agencies or courts require the help of a medical man for that purpose¹. The medical man by ascertaining age, sex, race and stature etc. assists the investigating agencies or courts to establish or

confirm identity of an individual in certain criminal and civil cases².

The bones of the human skeleton develop from separate ossification centers and growth from these centers of ossification progresses till the bone is completely formed. The Clavicle is a long bone with a medullar cavity like the other long bones and first fetal bone to undergo ossification by membranous ossification without prior endochondral ossification, unlike other long bones. The ossification initially starts with two primary ossification centers, one medial (sterno-mastoid pectoralis major end) and the other lateral (trapezius deltoid end) during 5th and 6th fetal week^{3,4}. So, to determine the period of age between 20-25 years the epiphyseal union at medial end of clavicle is studied in this part of the world as several studies indicate that medial end of clavicle unites at about the age of 22 years, according to reddy fusion of medial end of clavicle occur at 20-22 years.

To estimate the age of persons who are assumed to be older than 18 years, it is particularly important to evaluate the progress of ossification of the epiphysis at medial end of clavicle, because all other developmental systems under examination have completed their growth by this time. These changes can be studied by means of radiological examination (X-rays). From X-rays the earliest appearance and subsequently the rate of growth of the ossification centre can be watched.

Roentgenographical method has however its own limitations though they are insignificant as compared to those of the other methods. Continuity of the bone pattern at one level may overlap and obliterate a break in the continuity at another level and may further obscure the picture. Also, the epiphyseal line may be obscured by superimposition of shadows of soft parts. Of the forensic methods recommended for age estimation, evaluating sexual maturity shows the largest range of variation and therefore should be used for age

determination only in conjunction with an evaluation of skeletal maturity and tooth development. From the study of various workers, it is well settled that there is not only variance in the timing of epiphyseal union in India and abroad but also in different states of India. Variation in the time of union so observed was attributed to factors like: climate, race, nutrition, heredity, sex, dietary habits and socio-economic status of population.

Owing to variation in climate, dietary, hereditary and other factors affecting the people of different provinces of India, it cannot be reasonably expected to formulate a uniform standard for determination of age of union epiphyses for the whole of India⁵. Due to the progressive development of bones, aging of skeletons under the age of 25 can be more easily accomplished utilizing the order of epiphyseal fusion in the long bones. The medial clavicular epiphysis matures relatively slowly. In the human skeleton, it is generally the last long bone epiphysis to fuse. Its developmental stage is therefore useful when estimating age of living persons involved in criminal proceedings. The present study has been undertaken to study roentgen graphically the epiphyseal appearance and fusion of medial end of clavicle in subjects between age group of 20 to 25 years.

Material & Methods

A community based cross sectional study done on randomly selected subjects of both sexes having age between 20 to 25 years of age amongst the visiting to MLC –OPD in Mahatma Gandhi Hospital /Mathuradas Mathur Hospital Jodhpur who will fulfill the selection criteria, after proper history taken in relation to age estimation, availability of certificate indicating the age of birth or any such relevant document and physical examination.

Inclusion criteria

- MLC cases of supposed age 20-25 yrs brought for age estimation by police to dept. of forensic medicine and

toxicology included in the study.

- THOSE cases were selected who had a valid proof of exact date of birth is and also consented to participate in the study.
- The case selected from the easily available general population to i.e patients admitted in wards, their relatives and police personnel visited the hospital.

Exclusion criteria

- Individual with pathological, nutritional, development & endocrinal abnormality which affects the skeletal growth.
- Subjects not given consent for X-ray.
- Subjects not had valid documentation for proof of age/date of birth.
- Satisfying the inclusion criteria were excluded from the study who had documentation for date of birth younger than 20 years of age & above 25 yrs of age.

In this study, one hundred subjects were taken (fifty males and fifty females) from Jodhpur between age group of 20-25 years. The individuals selected for study were in the age range of 20 to 25 years further grouped into one year intervals of 20-21yrs, 21-22 yrs, 22-23 yrs, 23-24 yrs, 24-25 yrs with equal numbers of both sexes included in each age interval.

Age of each individual studied was confirmed from a valid date of birth certificate like-secondary school certificate, Aadhar card, driving license, passport, ration card or voter's identity card. Age, as stated by them was further confirmed by obtaining a copy of birth certificate or school record duly verified by the head of the school & confirmation from the parents.

The results for union of epiphyseal center for medial end of clavicle were assessed considering a stage five system proposed by Schmeling et al (2004)⁶ and categorized into following group centre not appeared, centre appeared but no fusion; centre appeared with partial fusion; completely fused with fusion line visible or not visible. These can be respectively compared

to stages I to 5 of Schmeling's five stage system. The stage 4 & 5 of Schmeling were considered in one group i.e. complete epiphyseal union with or without fusion line. Thus for the purpose of statistical analysis, the epiphyseal union was divided into following four stages:

STAGE	APPEARANCE AND FUSION	GRADE (in master chart)
I	Centre not appeared	A
II	Centre appeared but no union	B
III	Union started but incomplete	C
IV & V	Complete union	D

Results

Although equal number of subjects were selected in each age group; they were having different ages, and hence the mean age was calculated for each group (table 1).

Males

In 20-21 yrs of age group, 0 cases (0%) centre not appeared, 4 cases (40%) centre appeared but no fusion, 6 cases (60%) union started but incomplete, 0 cases complete union occurred. in 21-22 yrs age group centre not appeared in zero cases (0%) and 0 cases (0%) shows appearance of centre but no union occurred, in 6 cases (6%) union started but incomplete, in 4 cases (4%) complete union occurred. In age group 22-23 yrs, zero cases (0%) centre not appeared, in zero cases (0%) centre appeared but no union occurred in 6 cases (6%) union started but incomplete, in 4 cases (4%) complete union occurred. In age group 23-24 yrs, zero cases (0%) centre appeared but no union occurred, in two cases (2%) union started but incomplete and in 8 cases (80%) complete union occurred. In age group 24-25 yrs, 3 cases (30%) union started but incomplete & in seven cases (70%) complete union occurred (table 2).

Females

In age group 20-21 yrs, in zero cases (0%) centre not appeared, in 6 cases (60%) centre appeared but no union occurred, in 4 cases (4%) union started but incomplete, in 0 cases complete union

occurred. In age group of 21-22 yrs, centre not appeared in zero cases, centre appeared but no union in zero cases, in eight cases (80%) union started but incomplete, in 2 cases (2%) complete union occurred. In age group 22-23 yrs, 0 cases shows centre not appeared and 0 cases shows appearance of centre but no union, in three cases (30%) union started but incomplete and 7 cases (70%) shows complete union. In age group 23-24 yrs, 0 cases shows centre not appeared and 0 cases shows appearance of centre but no union, in three cases (30%) union started but incomplete and 7 cases (70%) cases shows complete union. In

24- 25 yrs age group, complete union occurred in 10 cases i.e. 100 % (table 3).

Comparison of the age range of complete union of medial end of clavicle for males and females does not show statistically significant relation (table 4). For the three different stages of fusion of the epiphyseal centre for medial end of clavicle the variation in mean age of males and females showed statistically significant results for stage C (incomplete union) of the present study. The commencement of fusion of epiphyseal centre started about more than a year earlier in females as compared to males (table 5).

Table 1: Mean Age of the Study Subjects for Different Age groups in both Sexes

Age (in years)	Male (Mean±SD)	Female (Mean±SD)
20-21	20.38±0.35	20.37±0.34
21-22	21.43±0.29	21.32±0.27
22-23	22.41±0.23	22.37±0.24
23-24	23.42±0.30	23.41±0.29
24-25	24.42±0.31	24.4±0.29

Table 2: Extent of Fusion of the Medial end of Clavicle in Different age group of Males

Extent of fusion	Age (in years) [N (%)]				
	20-21	21-22	22-23	23-24	24-25
Centre not appeared	0	0	0	0	0
Centre appeared but no union	4	0	0	0	0
Union started but incomplete	6	6	6	2	3
Complete Union	0	4	4	8	7

Table 3: Extent of Fusion of the Medial end of Clavicle in Different age group of Females

Extent of fusion	Age (in years) [N (%)]				
	20-21	21-22	22-23	23-24	24-25
Centre not appeared	0	0	0	0	0
Centre appeared but no union	6	0	0	0	0
Union started but incomplete	4	8	3	3	0
Complete Union	0	2	7	7	10

Table 4: Age of Incidence of Complete Union in All Subjects

Age (in years)	No. of cases	For male No. of cases with complete union	For female No. of cases with complete union	p value
20-21	10	0	0	NA
21-22	10	4	2	>.05 (NS)
22-23	10	4	7	>.05 (NS)
23-24	10	8	7	>.05 (NS)
24-25	10	7	10	>.05 (NS)

Table 5: Statistical Parameters by sex for Ossification Stages of Clavicle

Stages	Sex	Mean±SD	p value
Centre appeared but no union	Male	20.12±0.18	0.491
	Female	20.2±0.14	
Union started but incomplete	Male	21.92±1.26	0.399
	Female	21.62±0.93	
Complete Union	Male	23.29±1.08	0.74
	Female	23.39±1.02	

Discussion

Controversies have existed from time to time especially in medicolegal work regarding the determination of age of a person. Age acquires more importance in cases of criminal responsibility, marriage, rape, personal identity etc. In the past, several illogical criteria have been used for assessing the age. A number of investigators have worked upon the age of union of various epiphyses but there are marked differences in their views.

The study group included 10 subjects of each sex for each age group. The mean ages for males and females were 20.38±0.35 years and 20.37±0.34 years for males and females respectively in 20–21 years age group; 21.43±0.29 years for males and 21.32±0.27 years for females in 21–22 years age group; 22.41±0.23 years for males and 22.3±0.24 years for females of 22–23 years age group; 23.42±0.30 years for males and 23.41±0.29 years for females in 23–24 years age group; 24.42±0.31 years for males and 24.4±0.29 years for females in 24–25 years age group.

In most studies done on age estimation using medial end of clavicle the variable age ranges have been included for study ranging from 3 to 32 years out of which majority of studies have included subjects ranging from 16 to 25 years of age. In a study done in Bhise SS et al⁷ broad age ranges of 9 to 25 yrs for males & 3 to 23 years for female were taken. In the study of Brown AA et al⁸ subjects ranging from 16 to 32 years of age were considered for the study of ossification of medial end of clavicle. In the study of Singh P et al⁹ the study subjects were from 16 to 25 years of age.

In present study, majority of cases show complete union at 22 years for both males and females. These findings are similar with results of Stevenson's P (1924)¹⁰; Parikh CK (India, 1990)⁴; Badgujar KP (Jaipur, 2006)¹¹ and Singh P et al, (Patiala, 2001)⁹. Our results are lower in comparison to those of Davies & Parson (England, 1927)¹²; Krogman (U.S.A, 1962)¹³; Stewart (U.S.A, 1973)¹⁴ and Inderbir (1990)¹⁵ but higher than the age group reported by Flecker (Australia, 1932)¹⁶; Galstaun (Bengalis, 1937)¹⁷; Chaurasia (India, 1980)¹⁸ and Vij K (India, 2001)¹⁹. Our results are similar for those of females being 21–22 years and lower to that for males being 23–24 years for males in comparison to the study of Bhise SS et al (Mumbai, 2010)⁷.

There is no variation in mean ages when sex comparison were made for the age of complete fusion in our study which is similar to that of Stevenson's (White and Negroes, 1924)¹⁰; Flecker (Australia, 1932)¹⁶; Singh P et al, (Patiala, 2001)⁹ and Badgujar KP (Jaipur, 2006)¹¹ but dissimilar to that of Galastaun (Bengalis, 1937)¹⁷; Brown AA et al. (Ghana, 2009)⁸ and Bhise SS et al (Mumbai, 2010)⁷ where female development preceded male development at the time of complete fusion.

Comparison of time of fusion of medial end of clavicle (in years) with that shown by other authors

Author	Year	Race	Sex					Earliest Union (Yrs)
			Male		Female		Mixed	
			Appear	Fusion	Appear	Fusion		
Stevenson's ¹⁰	1924	White & Negroes	–	22–24	–	22–25	–	18
Davies & Parson ¹²	1927	English	–	–	–	–	25	–
Flecker ¹⁶	1932	Australians	–	21	–	21	–	–
Galstaun ¹⁷	1937	Bengalis (Indians)	15–19	22	14–16	20	–	–
Krogman ¹³	1962	USA	–	–	–	–	25–28	–
Stewart ¹⁴	1973	USA	–	26 or More	–	–	–	–
Chaurassia ¹⁸	1980	Indian	–	–	–	–	21–22	–
Parikh ⁴	1990	Indian	–	–	–	–	22	–
Inderbir ¹⁵	1993	Indian	–	–	–	–	25	–
Krishan Vij ¹⁹	201	Indian	–	–	–	–	20–22	–
Singh P ⁹	2001	Punjab (indian)	–	22–23	–	22–23	–	M=21 F=20.1
Schmeling A ⁶	2003	Germany	16	21–26	16	20–26	–	–
Badgular KP ¹¹	2006	Jaipur (India)	16–17	20–21	15–16	20–21	–	–
Brown AA	2009	Ghana	18	21–32	17	20–31	–	M=21 F=20
Bhise SS ⁷	2010	Mumbai (India)	–	23–24	–	21–22	–	M=21 F=20
Present Study	2014	Jodhpur (india)	–	22	–	22	–	M=21.6 F=21.2

Conclusion

It is concluded from the present study that the complete epiphyseal union at medial end of clavicle in population of Jodhpur region occurred at the age of 22 years, in both males and females. Hence, epiphyseal union of medial end of clavicle can be used as a parameter to ascertain age between 20-25 years along with other bony parameters. However, these figures cannot be applied to the other races and geographical areas in criminal investigations as different races and different populations have variations in the age of union of medial end of clavicle.

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