

An Original Research Article

An Observational Study of Radiological Age & Documented Age in 16-20 Years of Age Group in Jaipur

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Abstract

Age estimation is an important exercise undertaken in clinical forensic medicine for various civil & criminal purposes. Present community based Descriptive Observational Study was carried out in S.M.S. Medical College, Jaipur. In this study majority of cases lower end of radius were fused in both genders at 18-20 years of age. The lower end of ulna bone was found to be fused in 69.33% cases. The iliac crest was found fused in 29.34% study subjects. The centre for ischial tuberosity had appeared in 90% males and in 97.44% females between 16-18 years but the process of fusion had not been initiated in any subject below 18 years of age. Complete fusion of ischial tuberosity to the pelvic bone was seen in 40% males and in 19.44% females above 18 years of age. Non-correlation of skeletal age to recorded age as per birth certificates was seen in 36% males and 16% females. Higher discrepancy was observed in rural subjects, non-vegetarian eaters and sports persons. Their skeletal age was ahead of their recorded ages. In a developing country like India, paucity of reliable documentary evidences like birth certificate. Non availability of reliable local data for estimation of age is an incriminating factor for miscarriage of justice.

Keywords: *Epiphyseal fusion, Ischial tuberosity, Ossification centre, Radiological age.*

Introduction

Age estimation in the living is one of the most important tasks especially in developing countries like India where birth records are often not well maintained. There is a variation in the timing of appearance and fusion of the epiphyses of the bones. Ossification is seen earlier in the tropical countries and in females. The variation in the age of appearance and the union of ossification is mainly attributed to various factors like climate, heredity, race, nutrition, dietary habits, gender and socioeconomic status of population. Scientific estimation of age of an

individual whether living, dead or from human remains is a vexing problem for personnel in Forensic Medicine in both civil and criminal matters.

Estimation of age is an important task and a valuable tool to assist in many civil and criminal procedures such as identification, consent, criminal responsibility, clinical examination, validity of will, attainment of majority, kidnapping, rape, criminal abortion etc. Especially in developing countries like India where majority of population is not aware of the importance of registration of births or the record of registration may not be properly maintained. The parameters used for estimation of age are mainly physical examination, dental examination and radiological examination. Physical examinations are not sufficiently accurate due to the wide variations in biological maturation in different individuals.

Age estimation in cadavers, human remains and living individuals is generally needed to live the issues with significant legal and social modification

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for individuals as well as for the community.¹ Various workers have made attempts to divide the human life into a succession of discrete growth phases and to analyze them in terms of alteration in the tissues of the body especially in skeleton. The bones of human skeletons develop from separate ossification centers. From these centers ossification progresses till the bone is completely formed. These changes can be studied by means of X-Ray & these changes are age related. It is therefore possible to determine the approximate age of an individual by radiological examination of bones till ossification is complete.

Material & Method

This study was carried out at the Department of Forensic Medicine, SMS Medical College,.

Study design: Community based Descriptive Observational Study.

Study period: December' 2016 to November' 2017.

Study universe: Students and staff of Medical, nursing & other paramedical college in Jaipur

Inclusion criteria:

- Subjects belonged to Rajasthan by origin.
- Subjects having documentary evidence of age in the form of birth certificate issued by competent authority
- Age group: 16-20 years.
- Subjects who gave their consent.

Exclusion criteria:

- Subjects without proof of birth record.
- Subjects below 16 years and above 20 years.
- Subjects with Severe malnutrition.
- Subjects with Chronic illness.
- Subjects with Endocrinal disorders.
- Subjects with deformities of limbs and pelvis.

Method of collection of data:

After obtaining consent from the subjects satisfying

the inclusion criteria and obtaining valid informed written consent, the general physical examination were conducted to know the health status and rule out any deformities to select the subjects after applying exclusion criteria.

Materials:

- Printer black ink
- Data collecting instrument, X-ray film
- Lead marker, lead apron
- 8 x 10 inches rigid cassette
- Film hanger (8" x 10")
- Developer Solution
- View box
- Magnifying lens
- Weighing machine and height measuring scale
- Performa

Sampling method:

- Stratified Random Sampling based on age.
- Sample size – 150(75 Boys+75girls)

Sample Size: Sample size was calculated to be 64 subjects at 95% confidence level and 20% relative allowable error assuming the proportion males who had fusion of trochlea in 16-20 years to be 61% (as per seed article). But for study purpose, 150 subjects were taken to increase the authenticity of results.

Method

After selection of cases, the personal details were recorded and after taking informed written consent clinical and dental examination was carried out and details recorded in pre-proposed Performa. The subjects were then be subjected to Digital X-ray examination of pelvis, Wrist and Elbow joints. The Radiographs were then be studied for appearance and fusion of ossification centers and age determination were done on basis of the table of Galustan in Modi's textbook of Medical Jurisprudence. The documented age of the subject was also noted and the determined age was analyzed in relation to the documented age (as per birth certificates).

Statistical Analysis

The finally analyzed data was tabulated in Microsoft Excel Worksheet and statistically analyzed using appropriate statistical software to determine its significance at 95% confidence limits. The collected qualitative data were expressed in groups, diagrams, proportion and percentages and analyzed using SPSS version 16 software & analyzed using chi square test. $P < 0.05$ were considered significant.

Aim

To study the correlation between ages determination by radiological examination of appearance and fusion of epiphyseal centers of Elbow, Wrist and Pelvis in relation to birth certificates in subjects between 16-20 years of age.

Objectives

- (i) To assess the age determination from appearance

and fusion of epiphyseal centers of Elbow, Wrist and Pelvis in subjects between

16-20 years of age using digital X-rays in Jaipur region.

(ii) To assess and compare radiological age to the documented age as per the birth certificate.

(iii) Suggestions for authenticity of age estimation from ossification centers.

Observation

In our study the majority of cases (54%) were between 18-20 years of age as per their birth certificates. Males were more (55.55%) amongst 18-20 years subjects and females were more (56.52%) amongst 16-18 year subjects.. Majority of subjects from rural region were males (62.31%) and those from urban regions were mostly females (60.49%).

Table 1: Gender wise distribution of epiphyseal fusion of elbow joint (n=150)

Epiphysis	Male	Female	Total
Non-Fused	01 (1.33%)	00 (0%)	01 (0.67%)
Process of Fusion	02 (2.66%)	01 (1.33%)	03 (2%)
Fused	72 (96%)	74 (98.66%)	146 (97.33%)
Total	75 (50%)	75 (50%)	150 (100%)

Table 2: Gender wise distribution of epiphyseal fusion of lower end of radius (n=150)

Epiphysis	Male (Years)		Female (Years)		Total
	16-18	18-20	16-18	18-20	
Non-Fused	13 (43.33%)	00 (0%)	16 (41.02%)	00 (0%)	29 (19.33%)
Process of Fusion	13 (43.33%)	03 (6.66%)	19 (48.71%)	00 (0%)	35 (23.33%)
Fused	04 (13.33%)	42 (93.33%)	04 (10.25%)	36 (100%)	86 (57.33%)
Total	30 (40%)	45 (60%)	39 (52%)	36 (48%)	150 (100%)

Table 3: Gender wise distribution of epiphyseal fusion of lower end of ulna (n=150)

Epiphysis	Male (Years)		Female (Years)		Total
	16-18	18-20	16-18	18-20	
Non-Fused	14 (46.66%)	00 (0%)	14 (35.89%)	00 (0%)	28 (18.66%)
Process of Fusion	13 (43.33%)	02 (4.44%)	03 (7.69%)	00 (0%)	18 (12%)
Fused	03 (10%)	43 (95.55%)	22 (56.41%)	36 (100%)	104 (69.33%)
Total	30 (40%)	45 (60%)	39 (52%)	36 (48%)	150 (100%)

Table 4: Gender wise distribution of epiphyseal fusion of iliac crest (n=150)

Epiphysis	Male (Years)		Female (Years)		Total
	16-18	18-20	16-18	18-20	
Non-Fused	29 (96.66%)	09 (20%)	39 (100%)	04 (11.11%)	81 (54%)
Process of Fusion	01 (03.34%)	11 (24.45%)	00 (00%)	13 (36.11%)	25 (16.66%)
Fused	00 (00%)	25 (55.55%)	00 (00%)	19 (52.78%)	44 (29.34%)
Total	30 (40%)	45 (60%)	39 (52%)	36 (48%)	150 (100%)

Table 5: Gender wise distribution of epiphyseal fusion of ischial tuberosity (n=150)

Epiphysis	Male (Years)		Female (Years)		Total
	16-18	18-20	16-18	18-20	
Non-appearance	03 (10%)	00 (00%)	01 (02.56%)	00 (00%)	04 (02.66%)
Non-Fused	27 (90%)	21 (46.67%)	38 (97.44%)	14 (38.89%)	100 (66.67%)
Process of Fusion	00 (00%)	06 (13.33%)	00 (00%)	15 (41.67%)	21 (14%)
Fused	00 (00%)	18 (40%)	00 (00%)	07 (19.44%)	25 (16.67%)
Total	30 (40%)	45 (60%)	39 (52%)	36 (48%)	150 (100%)

Out of the total 150 cases, there were 69 cases in the 16-18 year age group and 81 cases in 18-20 year age group as per the available date of birth proofs. Amongst them 10 cases in the 16-18 years age group and 29 cases in the 18-20 years age group did not correlate to their recorded date of births.

Table 6: Gender wise distribution of correlation & non-correlation of fusion of Joint with demographic variable

Demographic	Correlation		Non-Correlation	
	Male	Female	Male	Female
Religion				
Hindu (n=121)	39 (32.23%)	51 (42.14%)	21 (17.35%)	10 (08.26%)
Muslim (n=29)	09 (31.04%)	12 (41.38%)	06 (20.69%)	02 (06.89%)
Residence				
Rural (n=69)	26 (37.68%)	22 (31.88%)	17 (24.63%)	04 (05.79%)
Urban (n=81)	22 (27.16%)	41 (50.61%)	10 (12.35%)	08 (09.88%)
Dietary Habits				
Vegetarian (n=104)	33 (31.73%)	48 (46.15%)	15 (14.42%)	08 (07.69%)
Non-Vegetarian (n=46)	15 (32.61%)	15 (32.61%)	12 (26.09%)	04 (08.69%)
Sports & Exercise Participation				
Yes (n=87)	42 (48.27%)	18 (20.69%)	24 (27.59%)	03 (03.45%)
No (n=63)	06 (09.52%)	45 (71.42%)	03 (04.76%)	09 (14.28%)

Discussion

Region of present study was an urban center but the students pursuing education from the institution come from different parts of Rajasthan on merit basis, contributing to a large proportion of rural population in the study subjects. Amongst the males included in the study more were from rural regions (57.33%) and Females belonging to urban region were in a higher proportion (65.33%) as compared to those belonging to rural regions. This distribution is understandable according to the female education rate in the state of Rajasthan, where even in recent times, female feticide, child marriage and prohibiting girls from achieving higher education are rampant in the society. Further

elaboration of results of radiological observations in study population for various demographic characteristics is done subsequently.

Bardale Rajesh (2011)² stated that the factors affecting appearing of ossification centers and fusion of epiphysis are climate, dietary habits, geographical variation, hereditary factors, and associations with diseases, growth and development. In the present study the fusion process of the secondary ossification centers was considered in three stages viz. non fused, in process of fusion and completely fused (with or without the line of fusion). In the present study, the elbow joint was not fused in only one male subject (0.67%). It was in the process of fusion in two male and one female study

subjects (2%). It had completely fused in rest 97.33% cases of both genders. These results are similar to those of **Sangma WBC, et al (2007)**³ who also observed complete fusion of elbow joint in 100% cases at the age of 16 years. Our results are also quite similar to those of **Bhise SS and Nandkar SD (2011)**⁴ who reported the complete fusion of elbow joint at 16-17 years in males and at 15-16 years in females. The slight variation seen in males was due to the regional variation in study population. **Galstaun G (1937)**⁵ from his study on Bengali subjects opined that complete union at the elbow joint occurred at 16 years, which is almost similar with the results of this study. **Basu SK and Basu S (1938)**⁶ recorded the latest time of fusion at the elbow as 17 years. These results show completion of ossification of Elbow joints at a slightly higher age as compared to our study which is probably due to regional variation in the two studies. **Aggarwal ML and Pathak IC (1957)**⁸ stated that in Punjabi girls, complete union occurred at the elbow at 16 years, which is almost similar with this study. **Chhokar V, et al (1992)**⁹ in their study of 200 female subjects of New Delhi found that complete fusion occurred at 14-16 years which is also in agreement to the observations of the present study. **Borovansky L and Hnevkovsky O (1929)**¹⁰ stated that the distal ends of radius and ulna fused with their shafts at about 19 years. This again is later than that observed in the present study and similar to the findings of **Nandy A (2010)**¹¹. **Chhokar V, et al (1992)**⁹ proposed that the distal ends of the radius and ulna fused with the shafts at 17-18 years, which lies quite within the range observed in the present study.

Hollinshead WH (1969)¹² documented that the iliac crest and the ischial tuberosity fused to the main mass by the age of 20-21 years. This is slightly dissimilar from the present study where these secondary ossification centers were found fused in about 50% cases. **Sankhyan S, et al. (1993)**¹³ also found that the iliac crest fused with the mass, ilium at the age of 21.5 years, which is also dissimilar to our finding.

After radiological examination of the elbow joint, wrist joint and pelvis; radiological age was assigned to each individual as per the proposed protocol. As per standard study of **Galastun G (1937)**⁵ on Bengalis, the radiological ages were grouped into 14-16, 16-18, 17-19, 18-20 and > 20 years for males; and, into 14-16, 16-17, 17-19, 18-20, 19-20 and > 20 years for females.

Out of rest 81 cases of 18-20 years age group, 52

cases had correlation of date of birth & radiological age, which was similar to results of **Dasgupta et al (1974)**³, **Galstaun G (1937)**⁵, **Banerjee KK and Aggarwal BB (1998)**⁷ and **Aggarwal ML and Pathak IC (1957)**⁸. Female subjects showed a higher correlation between recorded and Radiological ages in the present study (84%) as compared to males (64%). The results could not be compared to any other study as no such exactly similar study could be found in literature.

Conclusion

Age estimation is an important exercise undertaken in clinical forensic medicine for various civil & criminal purposes.

The epiphyses around the elbow joint were completely fused in 97.33% study subjects by the age of 16 years in both males and females.

Complete fusion of lower end of Radius and Ulna were observed at 18 years of recorded age in the present study in both genders.

The epiphyseal union of iliac crest was completed by the age of 20 years in both genders. The commencement of the epiphyseal union of iliac crest and ischial tuberosity was not observed before 18 years of age in this study.

Non-correlation of skeletal age to recorded age as per birth certificates was seen in 36% males and 16% females. Higher discrepancy was observed in rural subjects, non-vegetarian eaters and sports persons. Their skeletal age was ahead of their recorded ages. Due variations in development of children, improved nutrition, physical changes, social pattern, changes in hormonal development, such studies must be done from time to time.

Conflict of Interest: Nil.

Source of Funding: Nil.

Ethical Clearance: Clearance was obtained from research and review board of S.M.S. Medical College and Hospital, Jaipur.

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