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Original Research Article

Age Estimation By Epiphyseal Union At Wrist Joint And Hand In Females

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ABSTRACT

Age being one of the primary characteristics in establishing the identity of the individual, its estimation becomes an important task for the forensic expert especially in developing countries where birth records are not well maintained. In living it is not only important for identification but also for various civil and criminal purposes. Even the courts in India accept the ossification test as the reliable indicator of age as compared to physical and dental assessment of age.
This study comprised of 250 female subjects from Puducherry region, India. The age group of the subjects ranged from 14 to 19 years. Radiographs of the right wrist joint with hand of these subjects were taken and the epiphyseal union of the centres at the wrist joint and hand were noted.

Keywords: Age estimation, Epiphyseal union, Wrist joint and hand, Radiographs.

Introduction

A doctor has both medical and legal duties in all medico-legal cases. As a forensic expert on duty, he is often required to give his opinion regarding the age of a person [1]. The gravity of the offense depends upon particular age and also certain rights are given to the individual only at a particular age. It is a vexing problem for medical personal to establish the age of a person, whether living or dead [2] Age estimation becomes an important task for the Forensic Expert especially in developing countries where birth records are not well maintained [3].
Moreover the most ticklish problem arises in estimation of age between 14 to 19 years age group the determination of the age of an individual is a task of considerable importance in cases for identification, employment, criminal responsibility, judicial punishment, consent, rape, criminal abortion, prostitution, kidnapping etc [4].
The only valuable and universally accepted scientific methods of estimating age in living in the order of merits are radiological examination, dental examination and physical examination of secondary sexual characteristics. Physical examination includes measurement of height, weight and body mass which will be helpful in estimating the age in a foetus and in early childhood. While secondary sexual characters, particularly in adolescent age are closely related to biological maturation and has multiple variants [5].
Dental examination is useful for age determination up to 14 years. But it is not of much help

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after the age of 14 years as all deciduous and permanent teeth are erupted except third molar between 12 to 14 years. Further, it also shows wide variation in eruption of third molar teeth from person to person. It is also useful towards identification of skeletal remains, especially in mass disasters like fires, bomb explosions, accidents due to air-crash, train accidents, ship or mine wrecks and earthquakes [6].

After puberty the process of growth in length of the long bones stops at different ages in different parts. This stoppage of growth process is indicated by radiological examination of fusion of the epiphysis with respective diaphysis [7].

Research workers in India and abroad have conducted studies and recorded an appreciable variation in the time of appearance of ossification centres and union of epiphysis with the respective diaphysis [8].

Radiological examination is more reliable compared to physical and dental examination for age estimation, especially at 14 to 19 years age group, hence the court relies more on the radiological opinion [9].

The appearance and fusion of ossification centres are affected by various factors like climate, heredity, diet and others. India is comprised of areas where climate, hereditary, dietary factors differ from region to region [10]. Hence, it is very obvious that separate data for different regions of India is must as a uniform yardstick is not possible for the whole of India.

Hence an attempt is made to study epiphyseal union at the wrist joint and hand in females, by radiological methods for age group 14 to 19 years in Puducherry region.

Objectives

1. To study the epiphyseal union at different ossification centres of the wrist joint and hand among 14 to 19 years in females.
2. To know the variability of age estimation by epiphyseal union at the wrist joint and hand in females.
3. To know the age based on epiphyseal union at the wrist joint and hand in each age group between 14 to 19 years of age in this region.
4. To compare the findings of this study with the findings of previous Indian studies.

Materials and Methods

Study setting

Departments of Forensic Medicine and Radiology, Sri Manakula Vinayagar Medical College & Hospital, Puducherry.

Study design: Cross sectional study

Sample and sample size

The study comprised of 250 female subjects residents of a village, town or city within a radius of 50 kms from Sri Manakula Vinayagar Medical College and Hospital, Puducherry, India. The age group of the subjects ranged from 14 to 19 years. Their ages as stated by them was further confirmed by documentary evidence (birth certificate).

Sampling method: Stratified random sampling.

Inclusion criteria

- Female subjects who are residents of any village, town or city within a radius of 50 kms from Sri Manakula Vinayagar Medical College and Hospital, Puducherry
- Female subjects completed 14 years of age but not completed 19 years of age.

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- Subjects with documentary evidence for date of birth (birth certificate).

Exclusion criteria

- Subjects with musculoskeletal disorders, nutritional disorders, endocrine disorders and chronic illness.

Materials used

Proforma, Digital radiographs of wrist joint and hand, Lead apron, Rigid cassette and Computer / Laptop

Method

The digital radiographs of the wrist joint and hand were taken by radiographic exposure of the students of Sri Manakula Vinayagar Engineering and Polytechnic College, Puducherry. For achieving the sample size, school students within the radius of 50 km from Sri Manakula Vinayagar Medical College and Hospital were considered.
The purpose of the study was explained to the parents and the subjects, written informed consent was obtained from the parents or guardians in subjects less than 18 years and permission of the Principal of the schools were obtained. Digital X- ray of the right wrist joint with hand- AP view was taken at the Department of Radiology at SMVMCH, Puducherry.
Stevenson's[11] classification of epiphyseal union was adopted in this study for interpreting the radiographs.

Stage I: No Union. Complete gap or space between the epiphyses & shaft of the bone.
Stage II: Partial Union. Partial closure of gap or space.
Stage III: Recent Union. Closure of the gap or space, but a thin line visible at the epiphyseo– diaphyseal junction.
Stage IV: Complete Union. Epiphyseal space is bony in architecture and indistinguishable from either epiphyses or diaphysis.

However, during this study for practical purpose the stage I and II were considered as not fused while stage III and IV as fused.

Statistical analysis

The data's were entered and analysed using Epi Info (version 3.5.4) software package and Chi- square test (χ^2) was applied for all the distributions.

Findings

Table 1: Age wise distribution of the subjects

Age range (years)	Females
14- 15	50
15- 16	50
16- 17	50
17- 18	50
18- 19	50
Total	250

For example the age range 14- 15 years denotes the subject who has completed 14 years of

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age but not completed 15 years of age and so on.

Table 2: Ossification pattern at wrist joint with hand

Centres	Incidence of Fusion more than 50% cases (Age range in years)	Incidence of Fusion more than 75% cases (Age range in years)	Incidence of Fusion in 100% cases (Age range in years)
Distal end of radius	-	17- 18	18- 19
Distal end of ulna	-	15- 16	17- 18
Base of 1st metacarpal	-	15- 16	16- 17
Heads of 2nd, 3rd, 4th & 5th metacarpal	-	15- 16	16- 17
Proximal & distal phalanx of thumb	15- 16	-	16- 17
Proximal, middle & distal phalanges other than thumb	15- 16	-	16- 17

- At 15- 16 years 50% fusion is seen at the proximal & distal phalanx of thumb, proximal, middle & distal phalanges other than thumb. 75% fusion is seen at the distal end of ulna, base of 1st metacarpal, Heads of 2nd, 3rd, 4th & 5th Metacarpal in this age group.
- At 16- 17 years 100% fusion is seen at the base of the 1st metacarpal, heads of 2nd, 3rd, 4th & 5th metacarpal, proximal & distal phalanx of thumb, proximal, middle & distal phalanges other than thumb.
- At 17- 18 years 75% fusion is seen at the distal end of radius and 100% fusion is seen at the distal end ulna.
- At 18- 19 years 100% fusion is seen at the base of the distal end of radius.

Table 3: Statistical analysis for fusion at different ossification centres

Ossification centres	χ^2
	Females
Distal end of radius	212. 01
Distal end of ulna	207. 29
Base of 1st metacarpal	203. 48
Heads of 2nd, 3rd, 4th & 5th metacarpal	206. 14
Proximal & distal phalanx of thumb	191. 82
Proximal, middle & distal phalanges other than thumb	191. 82

Chi- square test (χ^2) was applied for the above distributions and it was significant with a statistically significant p value (< 0. 05) for the degree of freedom (df) of 4.

Table 4: Epiphyseal union at different ossification centres by different workers in females

Ossification centres	Gupta KN (Uttar Pradesh)	Galstaun (Bengal)	Nandy A (West Bengal)	Bhise SS (Mumbai)	Kagne (Maharashtra)	Pillai (Madras)	Present study
Radius- distal end	-	16.5- 18	17- 18	16- 17	17- 18	14- 18	17- 18
Ulna- distal end	-	17	17	16- 17	16- 17	14- 18	15-16
Base of 1st	15- 16	14- 15	15- 17	15- 17	15- 16	14- 17	15- 16

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metacarpal							
Heads of 2nd to 5th metacarpals	15- 16	14- 15	15- 17	-	15- 16	14- 17	15- 16
Phalanx(thumb) a. Proximal	-	-	15- 17	15- 17	15- 16	-	16-1 7
b. Distal	-	-	15- 17	15- 17	15- 16	-	16-1 7
Phalanges a. Proximal	15- 16	14- 15	15- 17	15- 17	15- 16	14- 17	16-1 7
b. Middle	15- 16	14- 16	15- 17	15- 17	15- 16	14- 17	16-1 7
c. Distal	15- 16	15	15- 17	15- 17	15- 16	14- 17	16-1 7

Discussion

In the present study, the average age of fusion at the distal end of radius is 17 to 18 years considering the incidence of fusion is more than 75% cases. Between 18 to 19 years of age, 100% of the subjects showed fusion and the results are consistent with the studies conducted by Yogesh S [12], Kagne RN, Nandy A [13] and Pillai MJS [14]. Lesser age of fusion is seen in Bhise SS [15], Kadam SS [16], Patil DT [17] and Galstaun G [18].

The average age of fusion of the distal end of ulna is 15- 16 years considering the incidence of fusion is more than 75% cases. Between 17 to 18 years of age, 100% of the subjects showed fusion and the results are consistent with the studies conducted by Kadam SS and Pillai MJS. The results are not correlating with that of Yogesh S, Bhise SS, Jain S, Kagne RN, Nandy A, Patil DT, Dasgupta and Galstaun who observed higher age group of fusion.

The average age of fusion at the base of first metacarpal, heads of 2nd, 3rd, 4th & 5th metacarpal is 15- 16 years considering the incidence of fusion is more than 75% cases. 100% of the subjects showed fusion in females it is seen in between 16 to 17 years and the results are consistent with the studies conducted by Kagne RN, Nandy A, Pillai MJS and Gupta KN.

The average age of fusion of the thumb (proximal & distal phalanx) is 16 to 17 years in females considering the incidence of fusion seen in 100% cases and the study results are not correlating with that of Bhise SS, Kagne RN and Nandy A who observed lesser age group for fusion in females.

The average age of fusion of the proximal, middle & distal phalanges other than thumb is 16 to 17 years in females considering the incidence of fusion seen in 100% cases and the results are not consistent with the studies conducted by Bhise SS, Kagne RN, Nandy A and Gupta KN who observed lesser age group for fusion.

From the present study it is evident that the epiphyseal union is variable when compared to the studies conducted in different parts of the country.

Incidence of fusion plays an important role in the variation of epiphyseal union, since few workers have considered 50% incidence of fusion, few as 75% and few considered 100% incidence of fusion. In our study, we have taken 75% incidence of fusion, as most of the workers considered it convenient and better.

Stevenson's staging of fusion was considered in our study in which stage I & II were considered as not fused and similarly stage III & IV were considered as fused which was followed in most of the studies.

Other dietary, sociological, racial, climatic, hereditary, environmental and geographical factors are also responsible for higher and lesser range of epiphyseal union at the different centres.

Conclusions

The following conclusions were drawn from the observations made in the present study.

1. The average range of epiphyseal union at the wrist joint and hand considering 75% incidence of fusion in Puducherry region is as follows.

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Ossification centres	Female Age range (years)
Distal end of radius	17- 18
Distal end of ulna	15- 16
Base of 1st metacarpal	15- 16
Heads of 2nd, 3rd, 4th & 5th metacarpal	15- 16
Proximal & distal phalanx of thumb	16- 17
Proximal, middle & distal phalanges other than thumb	16- 17

2. The epiphyseal union at all the centres at hand and wrist will show fusion before completion of 18 years age when the incidence of fusion is taken as 75%.
3. A wide range of centres are available at hand and wrist joint, hence it is significant in the age range of 14 to 19 years.
4. Even though the radiological examination is the most reliable method for visualizing the epiphyseal union of the bones, exact and precise age of the individual cannot be stated, but a reasonable age range can be given based on the epiphyseal union. Radiological examination of epiphyseal union at the wrist joint and hand is of adequate help, but with limitations.
5. As this study is done in Sri Manakula Vinayagar Medical College and Hospital, Puducherry covering 50 kms distance region i.e., a particular area, it may be considered to include the entire Puducherry union territory to come out with generalized and uniform results.
6. To reduce the error of margin, other factors like secondary sexual characters and dental examination are to be considered. The courts also require authenticity and a least possible margin of error for estimation of age. So it is better to study more centres and consider other factors in future to fulfill the need of the courts for reliability.

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Conflict of Interest: Nil

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