Radiological study of epiphyseal fusion process at head of femur in age group of 12-20 years

Raloti Sandip1*, Jhaveri Shailesh2, Shah Kalpesh3, Rajendra Kharadi4

1Assistant Professor, Department of Forensic Medicine & Toxicology, SMIMER Medical College, Surat
2Associate Professor, Department of Forensic Medicine & Toxicology, SMIMER Medical College, Surat
3Professor, Department of Forensic Medicine & Toxicology, B. J. Medical College, Ahmedabad
4Resident, Department of Forensic Medicine & Toxicology, M. P. Shah Medical College, Jamnagar

ABSTRACT

BACKGROUND: Age estimation in living as well as dead is a prerequisite for personal identification and it is increasingly important in criminal and civil matters. The growth of the human skeleton is of major importance for the aging process as the appearance of ossification centers and union of epiphysis relate to a fairly definite sequence and time table that makes skeletal maturity a reliable age indicator according to sex and ethnic differences. This present work is carried out to study the epiphyseal fusion of head of femur bone in relation to age, sex, physical development, and nutritional status. MATERIALS AND METHODS: The present study was conducted in the Department of Forensic medicine & Toxicology and Department of Radiology at B.J. Medical College & Civil Hospital, Ahmedabad during the year 2010-2012 on 80 males and 80 females from the age-group of 12-20 years. RESULTS AND CONCLUSION: The epiphyseal fusion in both male and female at head of femur starts by the age of 13-14 years and complete by 17-18 years in male and 16-17 years in females. It is not found any effect of the dietary habit, height, and weight on the timing of epiphyseal fusion of head of femur.

Key words: Epiphyseal fusion, Head of femur, Age estimation, Association

INTRODUCTION

Age estimation in living as well as dead is one of the most important tasks for a forensic practitioner4. In developing countries like India because of illiteracy, the births are not registered or records of birth are not properly maintained. It is a prerequisite for personal identification and it is increasingly important in criminal and civil matters. In fact, if doubt arises regarding the age of a person in any legal inquiry, forensic age estimation is promptly requested by authorities to ascertain whether the person concerned has reached the age of immutability. Here, age estimation becomes a valuable tool to assist in administration of many civil and criminal procedure codes such as identification, consent, clinical responsibility, clinical examination, and validity of will, attainment of majority, kidnapping or abduction, rape, criminal abortion 5.

There are 3 steps for age estimation

- Physical examination
- Radiological examination
- Dental examination

Corresponding Author:
Raloti Sandip,
Assistant Professor,
Department of Forensic Medicine & Toxicology,
SMIMER Medical College, Surat
Email: sandip0raloti@gmail.com

*ORIGINAL ARTICLE

Radiological study of epiphyseal fusion at head of femur in 12-20 years age group

Email: sandip0raloti@gmail.com
SMIMER Medical College, Surat

INTRODUCTION

Age estimation in living as well as dead is one of the most important tasks for a forensic practitioner4. In developing countries like India because of illiteracy, the births are not registered or records of birth are not properly maintained. It is a prerequisite for personal identification and it is increasingly important in criminal and civil matters. In fact, if doubt arises regarding the age of a person in any legal inquiry, forensic age estimation is promptly requested by authorities to ascertain whether the person concerned has reached the age of immutability. Here, age estimation becomes a valuable tool to assist in administration of many civil and criminal procedure codes such as identification, consent, clinical responsibility, clinical examination, and validity of will, attainment of majority, kidnapping or abduction, rape, criminal abortion 5.

There are 3 steps for age estimation

- Physical examination
- Radiological examination
- Dental examination

Corresponding Author:
Raloti Sandip,
Assistant Professor,
Department of Forensic Medicine & Toxicology,
SMIMER Medical College, Surat
Email: sandip0raloti@gmail.com

*ORIGINAL ARTICLE

Radiological study of epiphyseal fusion at head of femur in 12-20 years age group

Email: sandip0raloti@gmail.com
SMIMER Medical College, Surat
Radiological study of epiphyseal fusion at head of femur in 12-20 years age group

Ahmedabad, Gujarat region that will help many civil and criminal cases to help in administration of justice.

MATERIALS AND METHODS
The present study was conducted in the Department of Forensic medicine & Toxicology and Department of Radiology at B.J. Medical College & Civil Hospital, Ahmedabad during the year 2010-2012. The subjects were selected on cross-sectional basis from the students of B.J. Medical College and patients or their relatives at Civil Hospital, original native of Ahmedabad region. Subjects with criteria affecting the growth of bones and epiphyseal fusion like congenital deformities, fracture cases, chronic illness, on steroid therapy etc., were excluded from the study.

A total 160 apparently healthy subjects, 80 males and 80 females, irrespective of caste and religion with known birth-date and from the age-group of 12-20 years were selected for the purpose of the study. The subjects who have completed 12 years of age but not 13 years were grouped in 12-13 years and similarly for other age-groups. Preliminaries of the subjects including sex, age, height, weight, dietary habits were recorded.

Purpose was explained to the subjects and written informed consent was obtained for the digital x-ray. X-ray of both hip joints showing both head of femur process of fusion starts and epiphysis completed and no white dense line visible at diaphyseal junction. This stages labelled as stage 0.

Variables were evaluated and analyzed statistically. Chi-square ($\chi^2$) test was used to compare variables and tests were considered significant when P-Value < 0.05.

RESULTS
Subjects of either sex (80 male and 80 female) were grouped into 8 age-groups from 12 to 20 year with difference of 1 year each. In our study the subjects for either sex were nearly equally distributed in all 8 age-groups (10 male and 10 female in each age group).

Table 1, Figure 1 and Figure 1ashowthat fusion process starts in males at the age of 13-14 years whereas in case of female it starts at the age of 12-13 years, and fusion process complete at the age of 17-18 years in male and 16-17 years in female. Thus from our study, we observe that in head of femur process of fusion starts and completes earlier in females then males.

Table 1: Sex wise differences for epiphyseal fusion of head of femur of both sides in either sex

<table>
<thead>
<tr>
<th>Age groups in years</th>
<th>Various degree of fusion in head of femur of both side in either sex</th>
<th>Total cases</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>+</td>
</tr>
<tr>
<td>12-13</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>13-14</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>14-15</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>15-16</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>16-17</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>17-18</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>18-19</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>19-20</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>30</td>
<td>9</td>
</tr>
</tbody>
</table>

0=Non-union, + =Beginning of union, ++ = Recent union, +++ = Complete union
Radiological study of epiphyseal fusion at head of femur in 12-20 years age group

Figure 1: x-ray showing recent union (++) and complete union (+++) of head of femur and in greater trochanter of femur in 16 years of male

Figure 1a: x-ray showing recent union (++) and complete union (+++) in head of femur and in greater trochanter of femur in 15 years of girl

Table 2 shows that the 122 subjects on vegetarian diet and 38 subjects on mixed diet were showing epiphyseal fusion of head of femur at various stages. It is observed that the number of cases on mixed diet is very small owing to the dietary habits of the people of Ahmedabad, Gujarat region. Nevertheless, from the available cases, it is not found any effect of the dietary habit on the timing of epiphyseal fusion of head of femur. It is observed that change in height group has no effect on the timing of epiphyseal fusion of head of femur. Although the fusion of the epiphysis with respective diaphysis is indicative of completion of the growth of long bones, it is not dependent on height as it is genetically determined. As per the average height of the individuals of Gujarat region and as also seen in the present study described in Figure 2, majority of males and females are in 151-170 cm height group. As per the average weight of the individuals of Gujarat region and as seen in the present study described in Figure 3, highest numbers of males and females are in 66-70 kg weight group. Our study shows that in all weight groups the cases are distributed in all four stages of epiphyseal fusion. There is no exact pattern to guide us timing of epiphyseal fusion as it is seen in different age groups. This suggests that with change in weight there is no effect on the timing of epiphyseal fusion of head of femur.
Radiological study of epiphyseal fusion at head of femur in 12-20 years age group

![Fig. 2: Gender & Heightwise Distribution](image)

![Fig. 3: Gender & Weightwise Distribution](image)

**TABLE- 2: Effect of diet on epiphyseal fusion of head of femur of both sides in either sex**

<table>
<thead>
<tr>
<th>Age groups in years</th>
<th>SEX</th>
<th>Effect of diet on fusion of head of femur of both side in either sex</th>
<th>Total cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>12-13</td>
<td>M</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>13-14</td>
<td>M</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>14-15</td>
<td>M</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>15-16</td>
<td>M</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>16-17</td>
<td>M</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>17-18</td>
<td>M</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>18-19</td>
<td>M</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>19-20</td>
<td>M</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>28</td>
<td>11</td>
</tr>
</tbody>
</table>

0=Non-union, +=Beginning of union, ++=Recent union, +++=Complete union
DISCUSSION
The demand of forensic age determination in living individuals deals mostly with juvenile or sub adults, as in most countries legal relevant age limit range between 12 to 20 years. Among the variety of scientific procedure available in age assessment, there is wide agreement about the methods based on sexual, skeletal, and dental maturity. However in age group 12-20years, x-ray of upper and lower end of femur to see epiphyseal fusion is most accurate method.Present work is done to estimate age from fusion of both upper ends of femur. Ossification of the head of femur is of medico-legal importance. Presence of its centre in a newly born child found dead indicates that the child was viable, i.e., it was capable of independent existence. The lower end of femur is the growing end. The lower epiphysial line passes through the adductor tubercle. The epiphysial line of the head coincides with the articular margins, except superiorly where a part of non-articular area is included in the epiphysis for passage of blood vessels to the head. In addition, the plane of this epiphysis changes with age from an oblique to more vertical one. Lots of work has been done on age determination from epiphyseal union. Most of them have done so in the second quarter of the present century. The work has been carried out in foreign countries as well as in India. Galstaun’s study over Indian population shows that complete fusion of lower end of femur occurs at >18 years in male and >17 years in female.

For our study, total 160 subjects were taken; subjects of either sex were grouped into 8 age groups from 12 to 20 year with difference of 1 year each year. Digital x-ray of both knees joint showing both head of femur were taken in antero- posterior view in all 160 subjects. Sex, height, weight, diet of each individual were noted and tabulated. All findings were analysed and compared with individual studies.

Our study shows that the epiphyseal fusion at head starts in males at the age of 13-14 years whereas in case of female it starts by the age of 12-13 years and completes by 17-18 years in male and 15-16 years in females. In present study age of epiphyseal fusion in male is 17-18 year, which is similar to study done by Ubelkar et al (USA 1989) and Galstaun et al (India 1937), while in studies done by Scheuer & Black and Hugo F.V. et al age of epiphyseal fusion in male was 16 and 15 years respectively. In the study done by Pillai M.J. et al, age of epiphyseal fusion in head of femur was 19-20 years, which suggest fusion is 1-year late in comparison to present study.

In present study age of epiphyseal fusion in female is 15-16 year, which is nearer to study done by Basu et al (Bengali) and Galstaun (1937), while in the study done by Ubelaker age of epiphyseal fusion in head of femur was 18 years, which suggest fusion is about 1year late in comparison to present study.

It is observed that the number of cases on mixed diet is very small owing to the dietary habits of the people of Ahmedabad, Gujarat region. Nevertheless, from the available cases, it is not found any effect of the dietary habit on the timing of epiphyseal fusion of head of femur. As per the average height and weight of the individuals of Gujarat region and as also seen in the present study, majority of males and females are in 151-170 cm height group and highest numbers of males and females are in 66-70kg weight group. It is observed that change in height group has no effect on the timing of epiphyseal fusion of head of femur. Although the fusion of the epiphysis with respective diaphysis is indicative of completion of the growth of long bones, it is not dependent on height as it is genetically determined.

CONCLUSION
We may conclude that the epiphyseal fusion in both male and female at head of femur starts by the age of 13-14 years in males whereas in case of females it starts by the age of 12-13 years and completes by 17-18 years in male and 15-16 years in females. The age for epiphyseal fusion of head of femur is bilaterally similar, i.e. it occurs at the same age in both sides. The epiphyseal fusion of head of femur occurs earlier by about one year in females as compared to males. There is no effect of diet (whether vegetarian or on mixed diet) on epiphyseal fusion of head of femur. There is no effect of height and weight on epiphyseal fusion of head of femur.
REFERENCES

2. Scheuer L , Sue B : Developmental juvenile osteology;Elsevier academic press, 2000