An overview of research on forensic age estimation in living individuals: experiences of Bakirkoy Training and Research Hospital, Istanbul

Oguzhan Ekizoglu, M.D.
drekizoglu@gmail.com
Bakirkoy Training and Research Hospital, Istanbul

- 57 different medical department
- Emergency service: 1000 patient per day
- Outpatient clinic: 8000 patient per day
Forensic age estimation in living individuals

Department of Forensic Medicine
- performing over 50000 clinical forensic medicine examinations per year
- performing over 1000 forensic age estimations per year

Department of Radiology
- performing over 140000 CT examinations per year
- performing over 145000 MRI examinations per year
Department of Forensic Medicine

Forensic Age Estimation

- Criminal responsibility 57%
- Civil Rights
  - Marriage 12%
  - Retirement 2%
  - Military 4%
- Refugees 25%
• Medial clavicular epiphysis
• Distal tibial epiphysis
• Calcaneal epiphysis
• Proximal tibial epiphysis
• Distal femoral epiphysis
• Iliac crest apophysis
• Spheno-occipital syncondrosis
• Sternal ossification areas
Medial clavicular epiphysis


- Materials and methods
  - 10-35 years
  - 503 patient (362 male and 141 female)
  - CT, Slice thickness 1 mm
  - Schmeling 5 stage system
Important age thresholds

- Stage 2: 14 years for male
- Stage 3: 16 years for both sex
- Stage 4: 20 years for both sex
- Stage 5: 25 years for both sex

Intraobserver kappa: 0.768
Interobserver kappa: 0.826
Medial clavicular epiphysis

Estimation of forensic age using substages of ossification of the medial clavicle in living individuals.

Materials and methods
- 13-28 years old
- 193 patient (129 male and 64 female)
- CT, Slice thickness 1 mm
- Kellinghaus et al. substage system
• Important ages
  ◦ Stage 3c: 19 years for both sex

Intraobserver kappa: 0.916

Interobserver kappa: 0.868
Distal tibial epiphysis

Magnetic resonance imaging of distal tibia and calcaneus for forensic age estimation in living individuals.
Ekizoglu O, Hocaoglu E, Can IO, Inci E, Aksoy S, Bilgili MG.

- Materials and methods
  - 8-25 years
  - 167 patient (97 male and 70 female)
  - 1.5-T MRI, Slice thickness 2-4mm
  - Saint-Martin et al. 3 stage system
Important ages

◦ Stage 2: 14 years for males and 12 years for females

◦ Stage 3: 15 years for males and 14 years for females
Calcaneal epiphysis

Magnetic resonance imaging of distal tibia and calcaneus for forensic age estimation in living individuals.
Ekizoglu O, Hocaoglu E, Can IO, Inci E, Aksoy S, Bilgili MG.

- Material and method
  - 8-25 years
  - 167 patient (97 male and 70 female)
  - 1.5-T MRI, Slice thickness 2-4mm
  - Saint-Martin et al. 3 stage system
• Important ages
  ◦ Stage 2: 14 years for males
  ◦ Stage 3: 16 years for males and 12 years for females

Intraobserver kappa: 0.811
Interobserver kappa: 0.802
**Proximal tibial epiphysis**

*Forensic age estimation via 3-T magnetic resonance imaging of ossification of the proximal tibial and distal femoral epiphyses: Use of a T2-weighted fast spin-echo technique.*  

- Materials and methods
  - 10-30 years
  - 503 patient (305 male and 198 female)
  - 3-T MRI, Slice thickness 2-4mm, T2 weighted
  - Dedouit et al. 5 stage system
- Important ages
  - Stage 3: 14 years for males
  - Stage 4: 17 years for males and 15 years for females
  - Stage 5: 18 years for males and 16 years for females
**Distal femoral epiphysis**

Forensic age estimation via 3-T magnetic resonance imaging of ossification of the proximal tibial and distal femoral epiphyses: Use of a $T_2$-weighted fast spin-echo technique.

- Materials and methods
  - 10-30 years
  - 503 patient (305 male and 198 female)
  - 3-T MRI, Slice thickness 2-4mm, T2 weighted
  - Dedouit et al. 5 stage system
• Important ages
  ◦ Stage 2: 14 years for males
  ◦ Stage 3: 16 years for males and 14 years for females
  ◦ Stage 4: 17 years for males and 16 years for females
  ◦ Stage 5: 22 years for males and 21 years for females

Intraobserver kappa: 0.961
Interobserver kappa: 0.885
Iliac crest apophysis

Computed tomography evaluation of the iliac crest apophysis: age estimation in living individuals.
Ekizoglu O, Inci E, Erdil I, Hocaoglu E, Bilgili MG, Kazimoglu C, Reisoglu A, Can IO.
Int J Legal Med. 2016 Feb 25

• Materials and methods
  ◦ 10-29 years old
  ◦ 380 patient (193 male and 187 female)
  ◦ CT, Slice thickness 1.5 mm
  ◦ Kreitner et al. 4 stage system
Important ages

- Stage 2: 12 years for both sex
- Stage 3: 14 years for both sex
- Stage 4: 17 years for both sex
Spheno-occipital synchondrosis

Forensic age estimation by spheno-occipital synchondrosis fusion degree: computed tomography analysis.

- Materials and methods
  - 10-25 years
  - 638 patient (399 male and 139 female)
  - 1mm CT images
  - Bassed et al. 5 stage system
Spheno-occipital synchondrosis


- Materials and methods
  - 7-21 years old
  - 1078 patient (455 male and 623 female)
  - 1.5-T MRI, Slice thickness 2-4mm
  - Bassed et al. 5 stage system
Important ages

- Stage 4: 13 years old both sex
- Stage 5: 14 years old male / 12 years old female

Intraobserver kappa: 0.954
Interobserver kappa: 0.907
Manubrio-mesosternal ossifications

Analysis of the manubrio-mesosternal and mesosterno-xiphisternal junctions to estimate age: a preliminary CT study. Medicine. Accepted paper.

- Materials and methods
  - 30-60 years
  - 509 patient (275 male and 234 female)
  - CT, Slice thickness 1 mm
  - 3 stage system (no fusion, partial fusion, complete fusion)
Important ages

- Stage 1-3: 30-60 years for both sex

Intraobserver kappa: 0.983

Interobserver kappa: 0.934
Mesosterno-xiphisternal ossifications

Analysis of the manubrio-mesosternal and mesosterno-xiphisternal junctions to estimate age: a preliminary CT study. Medicine. Accepted paper.

- Material and method
  - 30-60 years old
  - 509 patient (275 male and 234 female)
  - CT, Slice thickness 1 mm
  - 2 stage system (no fusion, complete fusion)
Important ages

Stage 1:
30-53 years for males
30-52 years for females

Stage 2:
30-60 years old for both sexes
Male

- Spheno-occipital syncondrosis, MRI 12 and 14 years
- Medial clavicular epiphysis using substages, CT 14, 16, 18 and 19 years
- Proximal tibial epiphysis, MRI 14 and 16 years
- Distal tibial epiphysis, MRI 14 years
- Medial clavicular epiphysis using Schmeling method, CT 14, 16, 20 and 25 years
- Iliac crest apophysis, CT 12 and 14 years
- Distal femoral epiphysis, MRI 14, 16, and 22 years
- Calcaneal epiphysis, MRI 14 and 16 years
<table>
<thead>
<tr>
<th>Bone</th>
<th>Imaging Modality</th>
<th>Age(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spheno-occipital syncondrosis</td>
<td>MRI</td>
<td>12 and 14</td>
</tr>
<tr>
<td>Medial clavicular epiphysis</td>
<td>CT</td>
<td>16 and 19</td>
</tr>
<tr>
<td>Iliac crest apophysis</td>
<td>CT</td>
<td>12 and 14</td>
</tr>
<tr>
<td>Proximal tibial epiphysis</td>
<td>MRI</td>
<td>16</td>
</tr>
<tr>
<td>Distal tibial epiphysis</td>
<td>MRI</td>
<td>12 and 14</td>
</tr>
<tr>
<td>Distal femoral epiphysis</td>
<td>MRI</td>
<td>14, 16, and 21</td>
</tr>
<tr>
<td>Calcaneal epiphysis</td>
<td>MRI</td>
<td>12</td>
</tr>
</tbody>
</table>